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Research to Identify Components of Energy-Related Wastes
A State-of-the-Art Report

Gulf South Research Inst, New Orleans, LA

Prepared for

Environmental Research Lab, Athens, GA

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Research and Development

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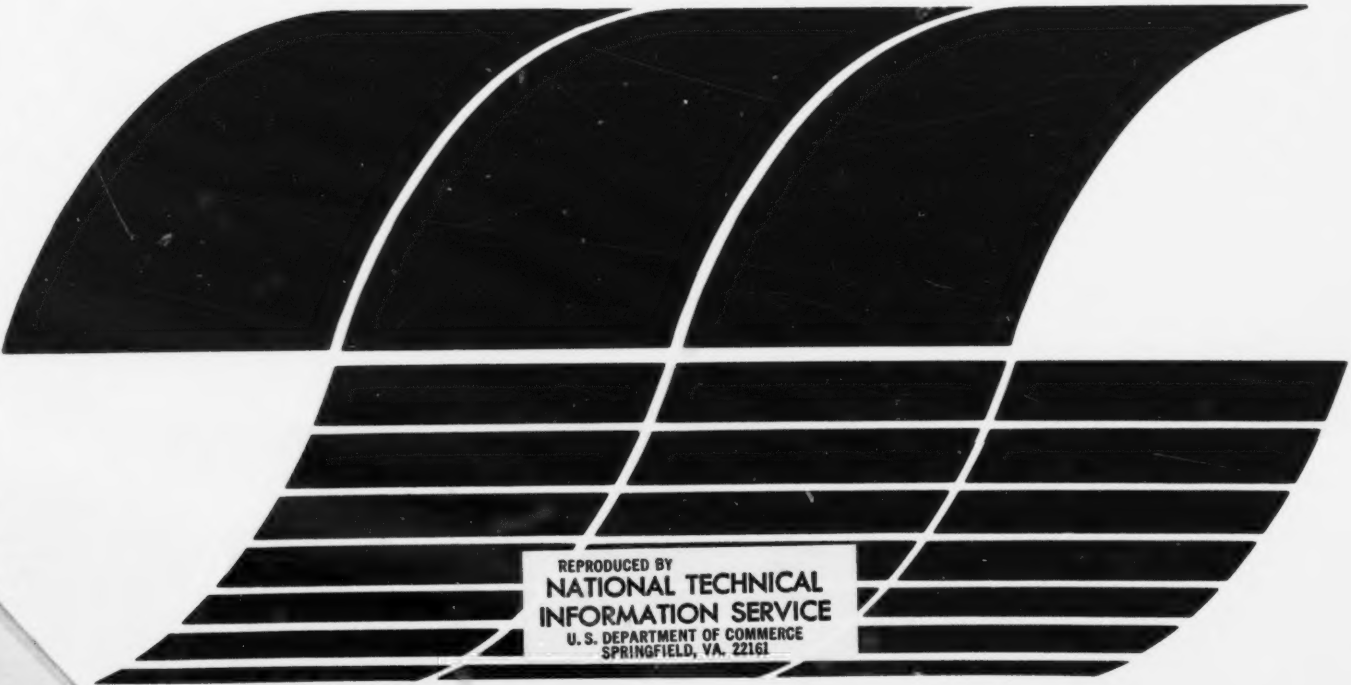
Research to Identify Components of Energy-Related Wastes

A State-of-the-Art Report

Interagency Energy/Environment R&D Program Report



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Pertinent abstracts from a survey of current (post-1976) research projects are categorized according to energy-related activity. Subjects include coal strip mines, oil refineries, oil shale operations, coal-fired power plants, geothermal energy production, coal liquefaction plants, and potential quality control standards. These references were obtained from the Smithsonian Science Information Exchange, Inc., and the National Technical Information Service of the U.S. Department of Commerce. Research projects and reports conducted before 1976 are compiled in Identification of Components of Energy-Related Wastes and Effluents (EPA-600/7-78-004). (PB-280 215)

Abstracts of available technical reports are also presented using the same energy categories. These reports were obtained from a variety of sources. Computer searches of several data bases, including MEDLINE, TOXLINE, BIOSIS, CAIN, NTIS, DIALOG, and Chemical Abstracts, have been conducted. Federal energy research centers supplied a large number of pertinent documents. This state-of-the-art summary is provided as an aid to researchers concerned with the environmental effects of energy-related activities.

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RESEARCH TO IDENTIFY COMPONENTS OF ENERGY-RELATED WASTES:
A State-of-the-Art Report

by

J.E. Gebhart and Mary M. McKown
Gulf South Research Institute
P.O. Box 26518
New Orleans, Louisiana 70126

Contract No. 68-03-2487

Project Officer

Ann Alford
Analytical Chemistry Branch
Environmental Research Laboratory
Athens, Georgia 30605

ENVIRONMENTAL RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
ATHENS, GEORGIA 30605

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This report has been reviewed by the Environmental Research Laboratory, U.S. Environmental Protection Agency, Athens, Georgia, and approved for publication. Approval does not signify that the contents necessary reflect the views and policies of the U.S. Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

FOREWORD

Nearly every phase of environmental protection depends on a capability to identify and measure specific pollutants in the environment. As part of this Laboratory's research on the occurrence, movement, transformation, impact, and control of environmental contaminants, the Analytical Chemistry Branch develops and assesses techniques for identifying and measuring chemical constituents of water and soil.

Efforts to achieve our national goal of energy independence will require increasing utilization of our country's vast domestic coal reserves as well as resources available from oil shale and tar sands. Production of synthetic fuels using coal gasification, coal liquefaction, oil-shale retorting, and other processes offers promise of meeting many of our energy needs. Of collateral importance with the production of energy,however, is assuring that toxic or undesirable substances in energy process effluent are identified and properly controlled to prevent human health problems and reduce environmental degradation. This state-of-the-art summary is provided as an aid to researchers concerned with the environmental effects of energy-related activities.

David W. Duttweiler
Director
Environmental Research Laboratory
Athens, Georgia

ABSTRACT

Pertinent abstracts from a survey of current (post-1976) research projects are categorized according to energy-related activity. Subjects include coal strip mines, oil refineries, oil shale operations, coal-fired power plants, coal liquefaction plants, geothermal energy production, and potential quality control standards. These references were obtained from the Smithsonian Science Information Exchange, Inc., and the National Technical Information Service of the U.S. Department of Commerce. Research projects and reports conducted before 1976 are compiled in Identification of Components of Energy-Related Wastes and Effluents (EPA-600/7-78-004).

Abstracts of available technical reports are also presented using the same energy categories. These reports were obtained from a variety of sources. Computer searches of several data bases, including MEDLINE, TOXLINE, BIOSIS, CAIN, NTIS, DIALOG, and Chemical Abstracts, have been conducted. Federal energy research centers supplied a large number of pertinent documents. This state-of-the-art summary is provided as an aid to researchers concerned with the environmental effects of energy-related activities.

This report was submitted in fulfillment of Contract No. 68-03-2487 by Gulf South Research Institute under the sponsorship of the U. S. Environmental Protection Agency. This report covers the period November 16, 1976, to November 15, 1978, and work was completed as of November 15, 1978.

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INTRODUCTION

To reduce the dependence of the United States on foreign sources of energy and still keep pace with increasing energy requirements, our national resources must be developed to a level unprecedented in our history. Alternate energy sources must be developed but only after consideration of the environmental impacts of their development. To prevent health problems and reduce environmental degradation, toxic or undesirable substances in wastes from energy-related activities must be identified and properly controlled. Analysis of liquid effluents and solid wastes provides information about the identities and concentrations of components. This information will assist researchers who are concerned with control technology, monitoring techniques, and the health and ecological effects of energy-related pollution.

A project to provide needed information about energy effluent composition was initiated by Gulf South Research Institute under sponsorship of the U. S. Environmental Protection Agency. To supplement other current and completed projects and avoid duplication of efforts, the first phase of this project was to identify gaps in existing data and probable future data on chemical elements and volatile organic compounds in solid wastes and aqueous effluents from energy processes. The scientific literature and various government reports were searched to determine which wastes and effluents had already been analyzed to identify and measure pollutants. Pertinent concurrent project reports and plans were reviewed.

Information obtained in the first phase of this project was compiled as a summary of research concerning identification and measurement of chemical elements and volatile organic compounds in wastes from oil refineries, coal strip mines, oil shale processors, coal-fired power plants, geothermal energy developments, and coal gasification and liquefaction plants. This information, which was used to select samples for analysis in the second phase of this project, is now being published for use by other researchers.

Projects cited are categorized according to type of energy activity. Current project reports or plans are summarized from information obtained from the National Technical Information Service and from automated searches conducted by the Smithsonian Science Information Exchange, Inc. Results of completed projects, as reported in the open scientific literature and in various types of government reports,are also presented.

In general, it might be noted that much of the work done in characterizing energy-related wastes and effluents has focused on the determination of metals, anionic species, and bulk parameters such as total organic carbon (TOC) and chemical oxygen demand (COD). Reports of efforts to identify organic components in energy-related wastes are few.

Data obtained from analysis of liquid effluents and solid wastes from energy activities will be published in a final report at the end of the contract performance period. That report will include identities and concentrations of organic compounds analyzed by computerized gas chromatography-mass spectrometry and chemical elements detected by spark source mass spectrometry (except for mercury, which was detected by flameless atomic absorption spectrophotometry).

ORGANIZATION:

U.S. Department of Agriculture
Cooperative State Research Service
Pennsylvania

TITLE:

Microspectrophotometric Analyses of Tissue Changes in Vertebrates Exposed to Water Pollutants

PRINCIPAL INVESTIGATOR:

A. Anthony
Penn. State University
Agric. Experiment Station
201 Shield Bldg.
University Park, Pennsylvania 16802

SUMMARY:

Develop and evaluate short term methods for detecting (by means of quantitative histochemical bioassays) the presence of hazardous levels of specified toxicants in streams.

Tissue samples will be obtained from fish exposed to sublethal and lethal levels of metal toxicants and acidity simulating conditions found in waters polluted by acid mine drainage. Laboratory and field studies will be made on fish subjected to acute (1-7d) and longer term (1 mo) exposures to different concentrations of heavy metal ions in acidified water. Emphasis will be on histophysiological effects of single metallic ions, ion-ion interactions and ion-acid interactions. Quantitative cytophotometry will be used to assess toxicant induced aspects of tissue damage.

ORGANIZATION:

U.S. Environmental Protection Agency
Office of Research and Development

TITLE:

Continuous Flow Bioassays Using Natural Periphyton Communities with Emphasis on the Effects of Coal Leachate

PRINCIPAL INVESTIGATOR:

Prof. D.Z. Gerhart
L.L. Holmetrand
T.J. Wood
J.R. Richter

SUMMARY:

Objectives of this project are 1) to quantify the effects of coal leachate on species composition and structures of periphyton communities; 2) to identify leachate components with inhibitory or stimulator effects; 3) to elucidate possible synergistic or antagonistic interactions among leachate components.

Approach: Periphyton communities are grown in laboratóry streams on artificial substrates. The bioassay facility utilizes water from Lake Superior and is located at the EPA's National Environmental Research Laboratory in Duluth, Minnesota. In experiments which last from 3 to 8 weeks, periphyton communities are dosed with various concentrations of coal leachare, coal distillate, or fractions thereof, and growth response is measured as changes in biomass (chlorophyll and ash-free dry weight). Algal communities are also examined microscopically to detect changes in species composition and diversity.

Current Plans and Progress: Coal leachate appears to stimulate the growth of algae. Current efforts are focusing on identifying the specific chemical factors responsible for this effect.

ORGANIZATION:

U.S. Department of the Interior Office of Coal Research

TITLE:

A Study of Coal-Associated Wastes Resulting from the Mining, Processing, and Utilization of Coal

PRINCIPAL INVESTIGATOR:

J.W. Leonard
West Virginia University
School of Mines
Morgantown, West Virginia 26506

SUMMARY:

Research at West Virginia University has been concerned with investigating all wastes and by-products associated with the conversion and utilization of coal. The objectives of this program are: 1) To characterize coal associated wastes both chemically and physically. 2) To propose and investigate possible utilization processes. 3) To suggest safe disposal methods for these materials, and 4) To describe their environmental impact on the Nation.

The coal-associated wastes under investigation include coal preparation wastes such as gob and coal fines, acid mine drainage (AMD) treatment wastes, "modified flyash" and other lime/limestone wastes resulting from sulfur dioxide abatement processes, coal ashes and those wastes which may result from the various coal conversion processes, among others.

Coal Strip Mining

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Investigation of Matrix Interferences for AAS Trace Metal Analyses of Sediments Affected by Coal Combustion and Acid Mine Drainage

PRINCIPAL INVESTIGATOR:

M.M. McKown
Gulf South Research Institute
8000 Gulf South Research Institute Avenue
Baton Rouge, Louisiana 70808

SUMMARY:

Soils and sediments subjected to pollution from coal production and combustion require analyses that are free of matrix interferences. Current practice does not take these interferences into account adequately. The experimental approach described below is designed to minimize this problem by providing the following information: The identity of interferents responsible for inaccurate trace metal determinations in the above cited source materials; Analytical methodology necessary to eliminate the matrix interferences which are the source of the difficulty; Data to establish accurate analytical procedures for the trace metal analysis of soils and sediment. These data will be in sufficient detail to allow translation of the procedure to other source materials.

Coal Strip Mining

ORGANIZATION:

U.S. Energy Research and Development Admin.
Div. of Biomedical and Environmental Research

TITLE:

Coal Conversion Pollutant Chemistry

PRINCIPAL INVESTIGATOR:

Dr. M.R. Peterson
P.W. Ryan
J.S. Fruchter

SUMMARY:

In this program we are characterizing the products, effluents and wastes from promising coal conversion processes. The objective of this work is to determine which substances may possibly enter the environment as a result of the full scale commercial operation of such processes. The initial work has been conducted at the solvent refined coal plant operated by Pittsburg and Midway Coal Mining Company at Fort Lewis Washington. The characterization program involves a comprehensive analysis of inorganic constitutents, of chemical species determination, and of organic materials for major and potentially hazardous constitutents. The samples include feed coal, solvent refined coal, mineral residue, by-product sulfur, light oil, wash solvent, recycle solvent, process waste water at various treatment stages, off-gas samples and aerosol materials collected over the cooling product. Instrumental neutron activation analysis, x-ray fluorescence and uv absorption spectroscopy are used to analyze solid and liquids for inorganic elements. Selective absorption traps are used to collect the various species of arsenic and mercury for analysis using plasma are emission spectroscopy. Solvent extraction techniques and gas chromatography coupled with mass spectrometry are used in analysis of the organic components.

Results: Three different sets of samples have been collected and analyzed. A total of about 65 aromatic, 25 aliphatic, 15 phenolic and 15 heterocyclic compounds have been identified. Concentrations of approximately 30 trace elements have been determined in both liquid and solids. A large fraction of the refractory and alkaline earth elements determined remains in the mineral residue. However, a substantial fraction of the zinc, tatalum and chromium and most of the bromine are carried from the coal into the product. None of the liquids contain elevated concentrations of the toxic trace elements.

Coal Strip Mining

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

State-of-the-art Evaluation on Petroleum and Coal Waste

PRINCIPAL INVESTIGATOR:

L. Streebin
University of Oklahoma
Research Institute
202 W. Boyd, Room 101
Norman, Oklahoma 73069

SUMMARY:

The final report to this study presents a state-of-the-art evaluation of pollution problems, abatement procedures, and control techniques relevant to the petroleum and coal industries. Petroleum wastes are discussed under three broad sections: drilling-production, transportation and storage, and refining. The results of a field study of three small refineries are reported, providing additional information which delineates the characteristics of waste streams from individual processes within the refinery. Coal mining, coal processing, and coal utilization, the wastes associated with each, and the corresponding control measures are discussed. Acid mine drainage, the most significant pollution problem from coal mining, and possible control measures are presented. The major pollution problems associated with coal processing originate from coal cleaning, the coking process, and refuse disposal. The principal pollutants in water discharge from the processing of coal are suspended solids usually in the form of fine clay, black shale, and other minerals commonly associated with coal. The production of coke by carbonization of coal produces a wastewater that is high in phenols, ammonia, and dissolved organics.

ORGANIZATION:

U.S. National Science Foundation

TITLE:

Mercury in the Environment at Alamaden, Spain

PRINCIPAL INVESTIGATOR:

U.S. Energy Res. & Dev. Admin.
Oak Ridge National Lab.
P.O.Box X
Oak Ridge, Tennessee 37831

SUMMARY:

Scientists from the Oak Ridge National Laboratory in cooperation with their colleagues at the Mines of Almaden in Spain, plan to conduct an ecological study of mercury in both the terrestrial and aquatic ecosystems in the vicinity of Almaden with the objectives of defining the range of mercury concentrations in critical ecosystem compartments, identifying indicator species (if they exist), and charting the distribution of environmental mercury away from the mining area. The significance of this study is based upon the fact that the Almaden mining operation generates the oldest and probably the most extensive case of mercury pollution in the world. The flora and fauna of the region are exposed to elevated levels of environmental mercury deriving both from rock weathering and from the mining-smelting processes. Effluents contaminate both the terrestrial and aquatic ecosystems, but neither the extent nor the effects of this contamination is known.

Coal Strip Mining

CURRENT PROJECTS:
OIL REFINERIES

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Identification and Measurement of Inorganic Compound Emissions

SUMMARY:

The Contractor shall review methods and develop procedures for the collection, identification, and measurement of the amounts of inorganic compounds emitted from sources using fossil fuels.
Laboratory evaluation and field testing at sources using or processing fossil fuel (fossil fuel power plant, oil refinery, and coal conversion) of the methods shall be conducted to obtain emission characterization data. This report shall be performed in three (3) distinct phases.

ORGANIZATION:

Oklahoma Gas & Electric Company

TITLE:

Studies on Environmental Pollution (1719 7306 7213 7202)

PRINCIPAL INVESTIGATOR:

R.W. Lappin
Oklahoma Gas & Electric Company
P. O. Box 321
Oklahoma City, Oklahoma 73101

SUMMARY:

Various studies concerned with pollution of air, water, and from noise. One study was to conduct an emission survey for nitrogen oxides emitted from boiler stacks. The tests would be conducted at normal full load firing of various boilers burning natural gas and/or fuel oil. The method used would be ASTM 1608. At the Seminole Generating Station an air monitoring station would be set up and operated in conjunction with Oklahoma State Department of Health in order to determine possible effects on ambient concentrations of nitrigen oxides, sulfur oxides, oxidants, ammonia, and particulate matter. Infrared photographs of Lake Konawa would be used in determining how much of the lake's area was being used in the cooling process. This type of image would give an instantaneous picture of heat flow and dissipation at the surface. A program to determine where high sound levels occur in plants and how this sound may be effectively contained and reduced if it exceeds the levels set for work areas.

ORGANIZATION:

University of Texas

TITLE:

Hydrocarbons Emitted During Aeration of Refinery Wastewater (Air Stripping)

PRINCIPAL INVESTIGATOR:

Prof. J.O. Ledbetter
University of Texas
School of Engineering
200 W. 21st
Austin, Texas 78712

SUMMARY:

The amounts of hydrocarbons stripped from refinery wastewater are being more carefully delineated than has been done in the past. Early measurements in the study are being made by measuring the reduction in carbon (total organic) when the wastes are aerated while no bacterial sludges are present. Later bench scale studies will involve the measurements and identification of the hydrocarbon emissions from model activated sludge models. The final phase of the study will be to measure the hydrocarbon emissions from a wastewater treatment unit at a refinery in order to check the hypotheses formed from the bench units.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Effects of Petroleum Compounds on Estuarine Fishes

PRINCIPAL INVESTIGATOR(S):

Dr. B.J. Martin and H.D. House

SUMMARY:

The purpose of this project is to study chemically induced tumors in teleost fishes. Both marine and freshwater species will be exposed to low levels of a known carcinogen for 300 days. Fish developing tumors or other pathologies during this period will be sacrificed and tissue from the liver, kidney, intestine, and gills will be studied histologically. Tissues from all the fish with no grossly apparent pathologies at the same time the experiment is terminated will be studied in the same manner in order to detect any neoplasias or preneoplastic conditions.

It is expected that this research will: (1) provide evidence concerning the quantities of benzopyrene necessary to induce neoplasias, (2) supply addition data concerning tumors in teleosts, (3) establish the feasibility of using teleost fish as early indicators of carcinogenic substances in the aquatic environment, and (4) demonstrate that this type system could be used to screen compounds for carcinogenic properties with less difficulty and expense than the methods currently employed.

ORGANIZATION:

U.S. National Science Foundation
Division of Advanced Environmental Research & Technology

TITLE:

Interdisciplinary Study of Environmental Pollution by Lead and Other Metals

PRINCIPAL INVESTIGATOR:

G.L. Rolfe
University of Illinois
Institute for Environmental Stud.
408 S. Goodwin
Urbana, Illinois 61801

SUMMARY:

This award provides support for a continuation of work under NSF Grant No ERT 74-24276 which is a comprehensive research program centered on the environmental impacts of automotive emissions from the combustion of leaded gasoline. This terminal phase of the project will include studies on effects of soil and atomospheric lead on crop yields of corn and soybeans. In addition, plant burdens of lead as a function of various soil lead levels will be studied. The distribution of lead in an urban area, including building interiors, will be determined to identify regions of elevated exposure. Lead samples will be characterized in terms of physical and chemical form as a first step toward identifying the environmental transport pathways and transformation of lead. A risk/benefit economic analysis will use data from this project and elsewhere to weigh the benefits of continued use of leaded gasoline against the risk to health and crop productivity.

Oil Refineries

ORGANIZATION:

U.S. Environmental Protection Agency
Office of Research & Development

TITLE:

Method for SSMS Fingerprinting of Oils

PRINCIPAL INVESTIGATOR:

C.E. Taylor
U.S. Environmental Protection Agency
National Environmental Research Center
Corvallis, Oregon 97330

SUMMARY:

A major problem in "fingerprinting" spilled oils for source identification is that exposure to weather, particularly ultraviolet radiation, changes some of the characteristices used to "fingerprint". Chemical elemental fingerprinting shows promise of providing stable "fingerprints". In this task, work performed under AEC contract AT (04-)-167 at Gulf General Atomic for elemental fingerprinting by neutron activation will be extended and spark source mass spectrometry will be applied to oils for "fingerprinting". SSMS offers the probability of considering those elements that are not amenable to neutron activation analysis. Oils already characterized will be investigated first to demonstrate the applicability of EPA's equipment. The technique will be extended to additional oils and eventually applied to oils from actual spills.

ORGANIZATION:

U.S. National Science Foundation
Division of Avvance Environmental Research & Technology

TITLE:

The Petroleum Industry in the Delaware Estuary

PRINCIPAL INVESTIGATOR:

W. Whipple
Rutgers the State University
Water Resources Research Institute
Old Queens Building
New Brunswick, New Jersey 08903

SUMMARY:

The main goals of the project are to (a) identify the nature and sources of petroleum pollutants entering the Delaware estuary in the Philadelphia area, and (b) evaluate the effects of the pollutants on aquatic biota. Previous work (NSF/RANN Grants GI-42282 and 75-21359) has shown that: (a) urban runoff and non-petroleum industries contribute more oil pollutants than do the refineries, and (b) current levels of petroleum wastes in the river are harmful to biota. Emphasis in the coming year will be on better definition of sources of hydrocarbon pollution, identification of specific toxicants in oils, evaluation of chronic effects on aquatic animals using an in-situ floating laboratory, and the effect of petroleum wastes on marshland ecosystems. The research is being done jointly by a team from Rutgers University and the Academy of Natural Sciences of Philadelphia. Source work is being accomplished by extending measurements from storm sewers and tributaries to the entire metropolitan area through examination of land-use patterns. The bioassay work is now moving from the laboratory into the field so that effects to biota can be measured in the natural environment.

Oil Refineries

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Ambient Hydrocarbon and Ozone Measurements Near a Refinery

PRINCIPAL INVESTIGATOR(S):

H. Westberg
M.W. Holdren

SUMMARY:

The primary objective of this study is to examine the impact of a petroleum refinery on downwind ambient air quality. Monitoring the production of secondary gaseous pollutants such as ozone and other monitoring systems will be employed to record chemical and physical changes in the plume as it disperses downwind of the refinery. Detailed analyses for hydrocarbons, the oxides of nitrogen, ozone, carbon monoxide, PAN and sulfur dioxide will be performed. The field program will be conducted during the summer of 1977 near a refinery that is isolated from other major hydrocarbon emission sources.

Oil Refineries

ORGANIZATION:

U.S. Energy Research & Development Administration
Division of Biomedical & Environmental Research

TITLE:

Environmental Pollution Analysis - Instruments and Methods

PRINCIPAL INVESTIGATOR:

Dr. N.A. Wogman
Battelle Memorial Institute
P. O. Box 999
Richland, Washington 99352

SUMMARY:

Before a realistic assessment can be made of the potential environmental impact of the pollutants from energy-generation technologies, it is essential that amounts and physical and chemical properties of associated pollutant materials be determined. Pollutants enter the environment as a result of fuel extraction, transport conversion, and utilization in energy production and should receive early and detailed characterization to provide the essential information for subsequent studies of their environmental impact. This program develops both laboratory and field instrumentation and methods for detailed pollutant analysis. It designs and evaluates new sampling and analysis techniques required to obtain maximum sensitivity under practical conditions, amd methods to study the physical and chemical forms of non-nuclear pollutants in the environment.

Results: A reliable, fast, inexpensive technique for the measurement of As, Cr, Cu, and Pb in natural waters as well as methods to measure Hg ions, methylmercury, dimethylmercury, and elemental mercury, were developed. Development of anodic stripping voltometry was initiated to determine those elements detectable by the method in natural waters. A method of using the coherent-incoherent scatter peaks in energy dispersive X-Ray Fluorescence allows accurate measurements to be made of trace elements in varying matrices with thin element standards.

Oil Refineries

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Report of Characterization of Organic Emissions from Petrochemical Sources

PRINCIPAL INVESTIGATOR:

H.M. Barnes
U.S. Environmental Protection Agency
Environmental Sciences Research Laboratory
Durham, North Carolina 27711

SUMMARY:

The objective of this task is to quantitatively and qualitatively determine the gaseous organic emissions from various petrochemical sources, principally those involving chemical processing.

Initial investigations involve studies at stationary sources emitting halocarbon compounds. The two sources examined thus far include a solvent degreaser using trichloroethylene and one using methylene chloride. Sequential samples are collected both at the point emission sources and at downwind fenceline locations and analyzed for halocarbons using GC/MS techniques.

Currently, a preliminary report on hydrocarbon characterization data available in the literature as well as a discussion of ongoing programs within the EPA, was issued in 8/76. A halocarbon emissions measurement report will be issued in 7/77.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Characterization and Nature of Organic Composition of Petroleum Refinery Wastewater

PRINCIPAL INVESTIGATOR:

Al Burlingame
University of California
School of Chemistry
Berkeley, California 94720

SUMMARY:

The proposed work will continue to be carried out in collaboration with the Robert S. Kerr Environmental Research Laboratory, Ada, Oklahoma, and the Southeastern Regional Laboratory, Environmental Protection Agency, Athens, Georgia, in an effort to determine the nature and composition of petroleum derived organics in refinery wastewater and their modification by a treatment system prior to discharge into the environment. The Mass Spectrometry Unit, Space Sciences Laboratory, University of California, Berkeley, will work closely with Southeastern Regional Laboratory in devising a "clean", effective separation scheme for compound classes by high resolution mass spectormetric analysis of steps in the separation scheme. This laboratory will subsequently carry out high resolution mass spectrometric analysis of steps in the separation scheme. This laboratory will subsequently carry out high resolution mass spectrometry and C_{13} nuclear magnetic resonance analysis of the fractions provided by SERL. Gas chromatograph-high resolution mass spectrometry will also be used in these studies. Capillary gas chromatography-low resolution mass spectrometry. It is expected that the following information on refinery wastewater will result from this interlaboratory cooperative study: 1) determination of what organics are discharged after typical refinery treatment; 2) determination of where in the refining and treatment processes these organics originate; 3) a knowledge of what happens chemically and biologically to organics during different treatments.

Oil Refineries

ORGANIZATION:

U.S. Environmental Protection Agency
Office of Research and Development

TITLE:

OH Reactions of Importance on Perturbed Troposphere and Trace Gases

PRINCIPAL INVESTIGATOR:

D.D. Davis
University of Maryland
School of Arts & Sciences
College Part, Maryland 20742

SUMMARY:

Task 1: The specific objectives of Task 1 in the second year of funding will be to determine rate constants for reaction of OH with p-xylene, m-xylene and ethyl benzene. In addition to the above rate measurements, mechanistic information will be obatined (i.e., primary and/or secondary products) on the reactions of OH with the compounds propylene, 1-butene, cis-2-butene, tetramethylethylene, benzene, toluene, xylene and ethyl benzene. The techniques to be employed in this study are (1) flash photolysis-resonance fluorescence and (2) laser flash photolysis-time resolved mass spectrometry.

Task 2: The objective of Task 2 will be to collect an extensive data base on the concentrations of the trace gases NO, NO_2, SO_2, oxone and on particles in oil fired power plant plumes located in northeastern U.S. These data will be collected via small aircraft at distances up to seventy miles when possible. Before, during, and after each sampling flight, meterological data will be collected to provide as complete a meteorological hisotry as possible for each sampling expedition. At least two different oil fired power plants will be examined in this study.

Oil Refineries

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Identify Organics in Petroleum Refinery Wastewaters

PRINCIPAL INVESTIGATOR:

A.W. Garrison
U.S. Environmental Protection Agency
Environmental Research Laboratory
College Station Road
Athens, Georgia 30601

SUMMARY:

Extracts from a typical refinery wastewater will be examined by gas chromatography/mass spectrometry to identify the compounds being discharged. Sampling points include the API separator effluent, Pasveer Ditch effluent and final lagoon effluent. Tentative identification of classes of compounds and some specific compounds will be available from EPA Grant R803019-01 and confirmations and quantitation of some of these will be attempted.

Oil Refineries

ORGANIZATION:

U.S. Environmental Protection Agency
Office of Research and Development

TITLE:

Identification of Pollutants in Petroleum Refinery Wastewaters after Activated Sludge Treatment

PRINCIPAL INVESTIGATOR:

Dr. Wayne Garrison
U.S. Environmental Protection Agency
National Environmental Research Center
Corvallis, Oregon 97330

SUMMARY:

The objective is the qualitative and quantitative analysis of specific organic pollutants discharged in a representative petroleum refinery wastewater that has been subjected to biological (activated aludge) treatment. By analyzing samples before, during, and after treatment, information is gained on those organics removed or reduced by the treatment, those which pass through the treatment system, and those which are either increased by the treatment or that are new compounds produced during the treatment. Identifications are made primarily by GC/MS and are supplemented by IR and NMR when necessary. Quantification of the individual compounds is based on GC peak areas after identifications are confirmed. Mass spectra of identified compounds are placed in computer libraries to aid other analysts in identifying them. Compounds identified are used by other programs for surveillance analyses, to evaluate treatment effectiveness, and to set effluent criteria.

ORGANIZATION:

U.S. Environmental Protection Agency
Office of Research and Development

TITLE:

Identification of Pollutants in Petroleum Refinery Wastewaters after Aerated Lagoon Treatment

PRINCIPAL INVESTIGATOR:

Dr. Wayne Garrison
U.S. Environmental Protection Agency
National Environmental Research Center
Corvallis, Oregon 97330

SUMMARY:

The objective is the qualitative and quantitative analyses of specific organic pollutants discharged in a representative petroleum refinery wastewater that has been subjected to biological (aerated lagoon) treatment. By analyzing samples before, during, and after treatment, information is gained on those organics removed or reduced by the treatment, those which pass through the treatment system, and those which are either increased by the treatment or that are new compounds produced during the treatment. Identifications are made primarily by GC/MS and are supplemented by IR and NMR when necessary. Quantification of the individual compounds is based on GC peak areas after identifications are confirmed. Mass spectra of identified compounds are placed in computer libraries to aid other analysts in identifying them. Compounds identified are used by other programs for surveillance analyses, to evaluate treatment effectiveness, and to set effluent criteria.

Oil Refineries

ORGANIZATION:

U.S. Department of Agriculture Cooperative State Research Service Wisconsin

TITLE:

Polycyclic Aromatic Hydrocarbons in the Environment

PRINCIPAL INVESTIGATORS:

J.H. Harkin
University of Wisconsin
Agriculture Experiment Station
116 Agriculture Hall
Madison, Wisconsin 53706

SUMMARY:

Determine the distribution and levels of polycyclic aromatic hydrocarbons is soil, water and plants in relation to point or diffuse sources of origin, e.g. from plants, incinerators, oil refineries, and automobile or marine engine exhausts. Make recommendations for land or water used that will avoid health hazards due to elevated concentrations of carcinogenic or cocarcinogenic polynuclear aromatic hydrocarbons.

Samples of soils, water, and plant materials will be collected from areas where enrichment of polycyclic aromatic hydrocarbons might be expected, e.g. from fallout near incinerators or oil refineries, from automobile exhausts near highways and in metropolitan areas, or from marine engine exhausts near marinas, as well as from control areas where background levels can be established. The hydrocarbon mixtures will be extracted, separated by high-pressure liquid chromatography and/or gas chromatography, and assayed by fluorescence spectroscopy. Regions of enrichment of these hazardous chemical will be made which will minimize the health hazard for these compounds.

Oil Refineries

ORGANIZATION:

U.S. Energy Research & Development Administration
Division of Biomedical & Environmental Research

TITLE:

Ecosystem Stability

PRINCIPAL INVESTIGATOR:

J. Harte
University of California
Lawrence Berkeley Laboratory
Berkeley, California 94720

SUMMARY:

We will examine the response of laboratory freshwater aquatic microcosms to specific energy-related stresses and assess the validity of a variety of possible predictive stability indicators. We will assess the impacts of petroleum surface films on net primary productivity, respiration, trophic structure, and chemical composition. We also propose to study, using a combination of pure cultures and our freshwater microcosms, manipulations (e.g. nitrogen additions) which would enhance the effectiveness of bacteria in metabolizing petroleum products. Theoretrical studies of stability properties of ecosystems will be continued with the objective of using specific models to help organize and clarify the experimental data obtained from our laboratory microcosms, and with the objective of discovering and understanding further candidates for stability indicators.

Results: We have demonstrated the practicality of aquatic microcosms as a research tool for studying ecological response to stress (LBL-5965, 5987). Many specific similarities and dissimilarities with natural systems have been elucidated and modifications of our earlier facility have been chosen on the basis of these studies.

Oil Refineries

CURRENT PROJECTS:
OIL SHALE OPERATIONS

ORGANIZATION:

U.S. Dept. of the Interior
Office of Water Research and Technology

TITLE:

Identification of Presumptive Carcinogenic Compounds Released to Water Supplies by Oil Shale

PRINCIPAL INVESTIGATOR:

Prof. V.D. Adams
D.L. Sorensen
D.B. Porcella

SUMMARY:

It is proposed to determine the potential mutagenic and carcinogenic hazards posed by the development of oil shale in Utah, Wyoming, and Colorado. The Ames test is perticularly well adapted for use in such a study because it provides a means for studying complex mixtures with the eventual goal of isolating the compounds that are the mutagens and carcinogens. It is proposed to test 1) raw shale, 2) spent shale development areas before and after the shale development, 3) leachate from the spent shale, and 4) chlorination and oxidation of products produced from chlorination or ozonization of drinking water supplies and wastewaters containing possible shale leachates.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Control Technology Survey of Paraho Retort

PRINCIPAL INVESTIGATOR:

Dr. J. Cotter
Thompson Ramo Wooldridge Inc.
1 Space Park
Redondo Beach, California 90278

SUMMARY:

A total environmental characterization of air emissions, liquid effluents and solid wastes is the objective sought for the Paraho surface retort at Anvil Points, Colorado. There are 2-week periods of survey which will occur in August 1977 and September 1977. The work will be performed at the site at the same time other EPA, ERDA, and DOD environmental and process sampling and analysis work is in progress. The sampling and analysis will include "on-site" gas chromatography to measure inorganic and light-end hydrocarbons in recycle gas streams as well as all previous "on-site" analyses.

ORGANIZATION:

U.S. Energy Research and Development Admin.
Div. of Environmental Control Technology

TITLE:

Analysis, Screening, and Evaluation of Control Technology for Wastewater Generated in Shale Oil Development

PRINICPAL INVESTIGATOR:

G.W. Dawson
B.W. Mercer

SUMMARY:

The program is designed to identify the capabilities of current technology to produce environmentally acceptable discharges from shale oil development wastewaters. Wastewaters related to shale oil development will differ significantly from those of the petroluem industry. Should improper or inadequate treatment technology be employed, shale oil development may threaten the quality of ground and surface waters with high dissolved solids levels, oxygen demand, and toxic trace materials. Experimental data will be generated utilizing bench and pilot-scale facilities to prepare mine and in situ retort waters for surface discharge, groundwater recharge, or land spreading. Work will focus on wastewaters from the Wyoming and Colorado tracts.

Results: A critical evaluation of wasteater treatment needs has been written identifying the areas of concern and some of the likely technologies which can be applied.

ORGANIZATION:

U.S. Department of the Interior

TITLE:

Sorption of Residual Organic Substances in Retort Waters by Spent Oil Shale Residues

PRINCIPAL INVESTIGATORS:

J.A. Leenheer
U.S. Department of the Interior
Geological Survey
Water Resources Division
Denver, Colorado 80225

SUMMARY:

The various oil-shale retorting processes produce 10-50 gallons of waste retort water per barrel of oil. This retort water contains 3,000-5,000 mg/l of dissolved organic substances. At present, retort water is disposed on spent oil-shale residues. Organic solutes may leach into ground water or run off into surface water if the sorptive capacity of spent oil-shale residues is exceeded. Because the sorptive capacity of spent oil-shale residues for residual organic substances in retort waters is unknown, there are no recommendations pertaining to the disposal capacity of spent oil shale organic substances in retort waters.

A preliminary objective will be to develop an organic water quality analytical program such that background concentrations of dissolved and sediment organic materials can be determined and characterized for surface and ground water in regions of oil-shale and coal development. The overall objective is to determine the capacity of spent oil-shale residues to adsorb and immobilize residual organic substances in retort waters. The sorptive capacities of the soils and sediments which underlie and which may be spread upon spent oil-shale residuals will also be determined.

Organic solutes in natural surface and ground water in regions of oil-shale and coal developemmt, and organic solutes in retort waters will be characterized with respect to elemental composition, compound class, and physical-chemical properties. Spent oil-shale residue, soil, and sediment adsorbents will be characterized with respect to surface area, permeability, porosity, elemental and mineralogical composition, functional group composition and saturating ions. Adsorption isotherms will be determined for retort water organic solutes on oil-shale, soil, and sediment adsorbents. Adsorption kinetics will also be studied to determine adsorption mechanisms.

ORGANIZATION:

U.S. National Science Foundation

TITLE:

Characterization of Contaminants in Oil Shale Residuals and the Potential for Their Management to Meet Environmental Quality Standards

PRINCIPAL INVESTIGATOR:

J.J. Schmidtcollerus
Denver Research Institute
University Park
Denver, Colorado 80210

SUMMARY:

Advancement in technology has contributed to making large scale production of fuel from oil shale more feasible and the need for new sources of energy has focused attention in obtaining oil from oil shales. Whether retorted externally or in situ, processing results in large quantities of spent carbonaceous ash residuals which will contain residual, volatile organic matter and polycondensed organic material (POM) with a potential for polluting air and water on a scale commensurate with the scale of processing, adversely influence the compaction of the residuals ash and provide a source of organic contaminants and inorganic salts to be solubilized by surface and ground water. This research is directed toward providing information needed for management of residual spent shale to minimize environmental impact. Objectives include: (1) Determination of the amount and kind of organic components in carbonaceous spent shale and in the process water from retorting operations. (2) Isolation and identification of the structure and composition of those compounds that are of known or suspected blastomogenic activity. (3) Investigation or the changes compounds may undergo in large storage sites and investigation of their impact on environmental quality including solubilization and leaching by ground and runoff water, volatization of potential air pollutants, identification of POM present in airborne carbonaceous particulate matter from oil shale processing operations and effect of possible auto-oxidation on volatilization or organic compounds from the waste and their transfer into air.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Energy-Related Ambient Air Quality Monitoring in the Wester Energy Development Area

PRINCIPAL INVESTIGATOR:

R.N. Smelling
U.S. Environmental Protection Agency
Environmental Monitoring & Support Laboratory
P.O. Box 15027
Las Vegas, Nevada 89114

SUMMARY:

Provide integrated and validated air quality monitoring data (baseline and trend) for the western area of the U.S. which are or will be impacted by energy-related development activities. The geographic coverage includes the Northern Great Plains, Four Corners Area, Colorado Plateau (Oil Shale), Black Mesa, Arizona and areas of New Mexico.

Approach: 1. Maintain inventory of existing and projected pollution sources and monitoring networks. 2. Integrate air quality monitoring data and assess impact of energy-related activities. 3. Conduct aircraft air quality monitoring missions to supplement ground-based network data.

Outputs: 1. Annual reports of ground based monitoring data; 2. Annual reports of airborne monitoring data.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Monitoring the Impact of Western Coal Strip Mining and Oil Shale Extraction on Groundwater Quality

PRINCIPAL INVESTIGATOR(S):

Dr. R. Tinlin

SUMMARY:

The principal objective is to develop and validate in at least two areas a strategy for monitoring groundwater quality alterations that are occurring or could potentially occur as a consequence of the strip mining of coal; mining and processing of oil shale; conversion of these resources; and effects of other related situations (such as population increases and industrial developments). The areas to be monitored will be in the western United States.

Approach: The development of the monitoring strategy will follow, in general, the methodology that is described in the recently printed EPA report entitled "Monitoring Groundwater Quality: Monitoring Methodology." A necessary prerequisite to the development of the strategy will be the collection and evaluation of considerable data on subjects such as the following: geology, water chemistry, identifiable pollutants, aquifer hydraulic characteristics, mining methods, land reclamation processes, oil shale processing methods, and practices for disposal of waste substances. The evaluations will include identification of pollutants and the prioritization of pollution sources. Actual field monitoring will be conducted to show the validity and method of application of the monitoring strategy.

Outputs: Outlines and draft materials for the first phase of the work have been prepared for Monitoring approaches and Methods; Sources of Pollution and Methods of Waste Disposal; Identification of Potential Pollutants; Groundwater Usage; and Hydrologic Framework.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Fugitive Dust from Oil Shale Extraction

PRINCIPAL INVESTIGATOR(S):

I. Zuckerman

SUMMARY:

Objective: To conduct a survey of the quantity of fugitive dust produced by oil shale extraction at the Anvil Points, Colorado, facility. To determine some of the major inorganic components of the dust.

Approach: High volume samples will be used to collect fugitive dust at the mine, along the haul road, near the crusher, and near the spent shale disposal area. Mass source spectrometry will be used for elemental analysis. Particle size distribution will be determined by cascade impactors.

Progress: Study is to commence in September, 1977.

CURRENT PROJECTS:
COAL-FIRED POWER PLANTS

ORGANIZATION:

U.S. National Science Foundation
Div. or Adv. Env. Res. & Tech.

TITLE:

Characterization of Hazardous Materials Emitted from Coal Combustion and Conversion

PRINCIPAL INVESTIGATOR:

G.R. Rolfe
Univ. of Illinois
School of Chemical Sciences
Urbana, Illinois 61801

SUMMARY:

Research is directed towards characterization of toxic materials emitted in effluents from coal conversion and combustion operations. Emphasis is placed on elucidation of the basic principles which govern formation and release of toxic trace metals and carcinogenic organic species during power generation. Studies are currently directed towards establishing the mechanisms whereby toxic species become associated with particulate matter and toward establishing the environmental impact of these materials when released.

ORGANIZATION:

U.S. National Science Foundation

TITLE:

Sources, Transformations, and Speciation of Atmospheric Pollutants

PRINCIPAL INVESTIGATOR:

W.H. Zoller
University of Maryland
School of Arts and Sciences
College Park, Maryland 20742

SUMMARY:

This is continuation of work under Grants GI-36338 and ESR-75-02667 on the trace elements and polycyclic aromatic hydrocarbons in size-graded particulates emitted by power plants (coal-and oil-fired), municipal refuse and sewage-sludge incinerators, automotive traffic, airports, and the rural background. The objective is to identify sources to toxic elements and to trace the origins of ambient particulates. A second objective is to elucidate certain aspects of homogeneous gas reactions in polluted air and to determine the conditions that control ozone formation in power-plant and industrial plumes.

This grant extends the study to the combustion of refuse-derived fuel and to industrial sources represented by steel-making, petroleum refining, cement manufacture, and nonferrous smelting. Trace elements are analyzed by neutron activation and atomic absorption. Polycyclic aromatic hydrocarbons are measured in the particulate and gas phases. Studies in the meterological forecasting of stagnation periods will assist in evaluating the significance of the source emissions.

Studies of rainfall pH will attempt to correlate the acidity of rain with the chemistry of power plant emissions.

Aircraft sampling will be continued to elucidate the factors controlling the appearance of ozone bulges in power plant and industrial plumes by coordinated measurements of ozone, hydrocarbons, nitrogen oxides, carbon monoxide, humidity, condensation nuclei, and temperature.

ORGANIZATION:

Southern California Edison Co.

TITLE:

Trace Elements From Oil and Coal Plants

PRINCIPAL INVESTIGATOR:

Southern California Edison Company
2244 Walnut Avenue
Rosemead, California 91770

SUMMARY:

Objectives: To identify, quantify and remove selected trace elements emitted by fossil fuel generating stations. Objectives: 1974 calendar year: 1. Development of methods for removing mercury and beryllium from stack gas. 2. Develop pilot plant for removal of trace elements. 3. SCE assessment for 15 participant trace element program. 1975 calendar year: 4. Additional development of analytical methods for trace elements. 5. Continuation of pilot plant development for trace element removal.

ORGANIZATION:

U.S. Energy Research & Development Administration
Division of Biomedical & Environmental Research

TITLE:

Biogeochemical Cycling in Aquatic Ecosystems of Trace Elements in Coal

PRINCIPAL INVESTIGATOR:

U.W. Elwood
U.S. Energy Research & Development Administration
Environmental Sciences Division
P. O. Box E
Oak Ridge, Tennessee 37831

SUMMARY:

Enrichment ratios for most trace elements in coal and coal ash (trace element concentration in coal or coal ash/trace element concentration in the earch's crust) vary between 2 and 400. Extraction, conversion, and combustion of coal release many of these elements to the biosphere, thus increasing their biogeochemical mobility and availability for accmulation in aquatic and terrestrial environments. Autochthonous detritus in estuarine environments has been found to become progressively enriched in certain trace elements, including Cu, Cd, Hg, and Mn, during decomposition. The exact mechanism of this enrichment in detritus and its potential impact, both on decomposition and remineralization processes and on the productivity of detritus-based food chains in aquatic ecosystems, are unknown. This program will examine the mechanism and rate of enrichment of three trace elements--Ni, Cd, and Cr--in biotic components of stream ecosystems, including a stream which receives trace elements from atmospheric deposition on the surrounding landscape and one which receives trace element contamination from fly-ash pond disposal. The goals of this program will be accomplished through integrated field and laboratory research using radionuclides and standard analytical methods for stable isotope analysis. The field sites are Walker Branch Watershed, an undisturbed forested watershed, and McCoy Branch, a small stream flowing from a fly-ash holding basin.

Results: Concentrations of Ni, Cd, Cr, C, N, and S in leaf detritus as a function of stage of decomposition in Walker Branch have been determined. Results show that concentration enrichment of all three metals occurs during the initial phases of detritus decomposition. Three major mechanism of Ni enrichment initially appears to be adsorption concentrations in finer particles of organic detritus which contain less organic matter and indicates that increasing specific surface area does not result in increased enrichment of these metals.

Coal-Fired Power Plants

ORGANIZATION:

University of Texas

TITLE:

Air Water & Quality Impacts of Acid Rainfall Formations

PRINCIPAL INVESTIGATOR:

Prof. H.B. Cooper
University of Texas
School of Engineering
200 W. 21st
Austin, Texas 78712

SUMMARY:

Field studies are being undertaken of the potential for acid rainfall formation in the Austin area. Measurements are being made of sulfate and nitrate acid-producing ions as well as buffering agents such as calcium and ammonium on rainfall pH values. Potential contributions of electric power plants by conversion from natural gas to fuel oil combustion material corrosion potential and water quality impactment. Background levels of rainfall acidity are being determined to show potential increases in sulfate aerosol formation caused by motor vehicle catalytic converters and increased coal combustion for electric power generation in Texas.

Coal-Fired Power Plants

ORGANIZATION:

U.S. National Science Foundation

TITLE:

Monochromatic Emissivity of Particles Formed in Pulverized Coal Combustion

PRINCIPAL INVESTIGATOR:

W.L. Grosshandler
Washington State University
School of Engineering
Pullman, Washington 99163

SUMMARY:

The emittance of a cloud of particles in a high-temperature combustion environment is a function of the particle size, the temperature and particle concentration distribution, the wavelength, and the emissivity of the partilces. An experiment will be conducted to evaluate the monochromatic emissivity of particles typical of those found in pulverized-coal combustion systems. By measuring the emission from the transmission through a high-temperature cloud of particles, the equation of transfer can be solved to determine the monochromatic emissivity of the particles themselves. The parameters which will be varied are particle temperature (300 to 1300 K), particle size (50 to 80 micron m), wavelength (1 to 5 micron m), and particle material. Different coals will be used, ranging from low to high ash content and containing variable C/H ratio. The coal will be partially oxidized in a flow reactor to simulate the cenospheres and ash residue found in actual combustion systems. The radiation measurements will be taken in an inert dry-nitrogen environment. The physical character of selected samples will be determined with a scanning electron microscope.

Potential Quality Control Standards

ORGANIZATION:

U.S. Environmental Protection Agency
National Environmental Research Center

TITLE:

Field Evaluation of a Sampling Procedure for Polycyclic Organic Matter Emission Measurements From Stationary Sources

PRINCIPAL INVESTIGATOR:

D.L. Harris
Monsanto Research Corporation
1515 Nicholas Road Box 8
Dayton, Ohio 45407

SUMMARY:

Objective: Monsanto Research Corporation will evaluate a previously developed (by Langston Laboratories) sampling system for polycyclic organic materials at an asphalt processing plant and a coal-fired power plant.

Approach: Field evaluation of the sampling system will be conducted at a coal-fired power plant and an asphalt batch plant to determine the repeatability of the sampling procedure and advantages of point sampling versus traverse sampling. The collected samples will be analyzed by gas chromatography/mas spectrometry quantitatively for 8 POM compounds and semi-quantitatively for 23 other POM compounds. Current Plans: Agreement has been obtained with suitable sampling sites and evaluation will be conducted and reported over the seven-month contract period.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Characterization of Gaseous Emissions from Stationary Sources by Remote Sensing

PRINCIPAL INVESTIGATOR:

W.F. Herget
U.S. Environmental Protection Agency
Emissions Measurments & Characterization Division
Durham, North Carolina 27711

SUMMARY:

Objectives: Use ground-base remote sensing methods to determine species identity and concentration of gaseous pollutants emitted by point and extended area stationary sources; determine optimum spectral regions for monitoring specific pollutants.

Approach: Longpath high resolution infrared spectroscopy will be used in absorption and emission to determine the spectral characteristics of gaseous pollutants emitted by a variety of sources. Laboratory spectra of various species will be obtained to assist in species identification and concentration determinations. Longpath gas-filter correlation methods will also be used.

Current plans/progress: Measurements using a grating spectrometer have been made at coal-burning power plants, incinerators, gas purification plants and carbon black plants. The grating spectrometer has been replaced with a Fourier transform spectrometer to greatly increase spectral resolution and sensitivity. A variety of sources will be studied in future years.

Coal-Fired Power Plants

ORGANIZATION:

U.S. Environmental Protection Agency
Office of Research and Development

TITLE:

Obtain High Resolution Long-Path Infrared Absorption
Spectra of Selected Gaseous Pollutants

PRINCIPAL INVESTIGATOR:

Dr. W.F. Herget

SUMMARY:

The purpose of this research effort is to obtain infrared spectra in absorption of a wide variety of gaseous pollutants as they are produced by stationary sources such as power plants, acid plants, oil refineries, etc. These data will be used principally to determine which spectral regions are most suited for measuring various pollutants, so as to minimize interferences from other species. The effects of atmospheric interferences will be studied. The instrumentation to be used in these stuides consists of a 1800 degree Kelvin blackbody source which can be located up to two miles from the receiver section; two-food diameter telescopic optics to collimate and collect infrared energy; and a monochromater, detector and associated signal processing equipment. The wavelenght range covered is 2 to 14 microns, and the spectral resolution is on the order of one wave number.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Methods for Identification and Measurement of Inorganic Compounds Emitted as Particulates from Sources using Fossil Fuels

PRINCIPAL INVESTIGATOR:

W.M. Henry
Battelle Memorial Institute
505 King Avenue
Columbus, Ohio 43201

SUMMARY:

Objective: The objective of the proposed program is to investigate methods of inorganic compound identification of particulate emissions, select candidate methods, and based on the results of laboratory and field trials, to develop, validate, and optimize a sampling and analytical methodology.

Approach: Subject to revision based on information obtained from a literature search the basic approach planned is: (a) obtain large amounts of representative combustion process emission samples and determine their complete cation-anion contents. Chemical and physical separations will be made of these followed by structural (diffraction, infrared) and valence state determinations. The objective here is to test and evaluate analytical technology. (b) By use of a large multifuel experimental furnace generate fossil fuel emissions under controlled combustion conditions and utilize an existing thermodynamic data base to predict logical forms of the combustion products to assist and guide the analytical techniques judged most useful via the Phase I efforts. (c) Field test the developed analytical techniques at up to four fossil fuel emission sources. Optimize and validate the methodology and describe performance specifications.

Current plans: Literature search plus survey of prior and on-going research programs followed up by personal discussions with identified researchers who have developed promising techniques. Concurrently large amounts of emission particulates from coal and oil combustion sources will be obtained for laboratory trials of methodology.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Measurement of SO_2, SO_3, and H_2SO_4 from Fossil-Fuel Fired Combustion Sources

PRINCIPAL INVESTIGATOR:

U.B. Homolya
U.S. Environmental Protection Agency
Environmental Sciences Research Laboratory
Durham, North Carolina 27711

SUMMARY:

The objective of this task is to characterize sulfur emission from coal and oil-fired combustion sources and to assess the adequacy of present emission factors and to study the characteristics of SO_3/H_2SO_4 formation and emission relative to operating parameters. Selected emission sources will be samples which represent a cross-section of boiler size, combustion operating conditions, emissions controls and fuel type. Samples will be collected and analyzed for SO_2, total water soluble sulfates, CO, CO_2, and oxygen. In addition, research measurements will be carried out to evaluate the adequacy of advanced methods and monitors for the characterization of emissions. Currently, data has bee n obtained from a three coal-fired sources and light oil-fired boilers which indicate a significant difference in emissions of SO_4 between coal and oil fuels.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Development of Particulate Emissions Sampling Technology

PRINCIPAL INVESTIGATOR:

K.T. Knapp
U.S. Environmental Protection Agency
Environmental Sciences Research Laboratory
Durham, North Carolina 27711

SUMMARY:

The objective of this task is to develop sampling interfaces and study these and other interfaces with various particulate emissions sampling devices and measurement systems.

The various components of the sampling systems will be carefully evaluated. This includes nozzles, probes, both standard and boundary layer dilution, filter types and sizes and gas flow measuring systems.

Currently, a boundary layer dilution probe is being tested both at the stationary source simulator and in the field at oil-fired and coal-fired power plants. Special sampling boxes for temperature control have been built and are now being used with various sampling devices.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Size Distribution and Other Properties of Particle Emission From Selected Sources Categories

PRINCIPAL INVESTIGATOR:

K.T. Knapp
U.S. Environmantal Protection Agency
Environmental Sciences Research Laboratory
Durham, North Carolina 27711

SUMMARY:

(1) The objective of this task is to determine the size distribution, density, shape and optical properties of particles emitted from various source industries. (2) Particles are collected from various preselected source industries by filters and size fractioning devices. The samples are analyzed in the lab for the physical properties of the particulate. (3) Currently, emissions from oil-fired and coal-fired power plants and municipal incinerators are being sampled.

Coal-Fired Power Plants

ORGANIZATION:

U.S. Environmental Protection Agency
Office or Research and Development

TITLE:

The Development of Fugitive Emissions Sampling Techniques

PRINCIPAL INVESTIGATOR:

H.J. Koinsberg
Res. Corp. of New England
125 Silas Deane Hwy.
Hartford, Connecticut 06109

SUMMARY:

To provide fugitive emissions measurement methodologies required for environmental assessment and control technology development projects related to stationary source energy and industrial process programs of the Environmental Protection Agency.

Conduct a continuing program of evaluation, development testing and field adaptation of measurement techniques for air-borne and water-borne fugitive emissions from process and effluent streams, including the following: Review current programs to identify measurements requirements. Formulate specifications for basic sampling and analysis procedures. Conduct laboratory and field studies to determine effectiveness of adapting procedures to specific process streams. Review and critique measurement programs developed or proposed in other EPA programs. Conduct sampling and analysis programs for special projects. Prepare documents defining recommended measurement procedures and their application to process streams.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Development of a Field Instrument for Continuous On-Stact Monitoring the Mass Concentration of Particulates in Stack Emissions

PRINCIPAL INVESTOGATOR(S):

J.W. Liskowitz
H. Perlis

SUMMARY:

The object of this program is to provide an instrument which can be mounted on a stack and continuously monitor the mass concentration of particulate emissions. The basis for this instrument is the measurement of the depolarization of backscattered polarized radiation. Such a monitor can be used for regulatory purposes, to evaluate the efficiency of abatement equipment, and to record for control purposes the particulate emissions under different plant operating conditions. Such information can be used to define the optimum plant and abatement equipment operating conditions required to meet acceptable particulate emissions standards for different types of fules. Optimization of the operation of the abatement equipment under different conditions would advance the state of the art of pollution abatement and lead to improved air quality.

ORGANIZATION:

Kentucky Center for Energy Research

TITLE:

Trace Elements in Airborne Emissions from Coal Combustion

PRINCIPAL INVESTIGATOR:

W. Lloyd
University of Kentucky
Graduate School
Limestone and Euclid
Lexington, Kentucky 40506

SUMMARY:

The project is an experimental study, in cooperation with the Physical Plant Division, University of Kentucky, of the distribution of minor and trace elements in airborne particulates from power plant coal combustion. It is planned to use both established quantitative techniques and three candidate modifications which are expected to enhance analytical sensitivities.

ORGANIZATION:

U.S. Energy Research and Development Administration
Biomedical and Environmental Research Division

TITLE:

Survey of Instrumentation for Environmental Monitoring

PRINCIPAL INVESTIGATOR:

D.A. Mack
University of California
Lawrence Berkeley Laboratory
Berkeley, California 94720

SUMMARY:

A critical and in-depth survey of instrumentation for environmental monitoring has been conducted for the past three years under the auspices of the RANN program of the National Science Foundation. Instruments and techniques being investigated are those useful for measurements in Air, Water, Radiation and Biomedicine related to the environment. The results of the survey include summaries of conditions giving rise to environmental problems, overviews of present methods of measurement, critical comparisons among instruments and instrumentation methods, and recommendation for the development of new instrumentation.

Results: Survey results entitled, "Instrumentation for Environmental Monitoring, "Lawrence Berkeley Laboratory Report LBL-1, are compiled into five loose-leaf binders to facilitate updating: Volume 1, Parts 1 and 2, Air Monitoring, covers sulfur dioxide, oxides of nitrogen, photochemical oxidants, hydrocarbons, metals, particulates and asbestos. Volume 2, Water Monitoring, covers trace metals, halides, nitrogen, phosphorus sulfur, biological parameters, pesticides, oil and grease, and turbidity. Volume 3, Radiation Monitoring covers ionizing and non-ionizing radiation. Volume 4, Biomedical Monitoring, covers gaseous pollutants, liquid pollutants, particulates, metals, pesticides and radiation.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Characterization of Effluents from Coal-Fired Utility Boilers

PRINCIPAL INVESTIGATOR:

Dr. B.G. McKinney
U.S. Tennessee Valley Authority
350 Evans Building
Knoxville, Tennessee 37902

SUMMARY:

The objectives of the project are to (1) characterize and quantify the chemical and physical components of coal pile drainage, (2) assess and quanitfy the chemical and physical nature of ash pond effluent after the pH of the ash pond has been adjusted to meet existing standards, (3) evaluate an ash pond monitoring program to determine the sampling necessary to obtain reliable, representative information, (4) assess and characterize coal ash leachate on ground water, (5) evaluate and quantify the chlorinated effluent in the discharge canal of a once-through cooling system, and (6) characterize the gaseous and particulate emissions from two plants with different type units, e.g. cyclone and tangential fired units.

The project will focus on determining the quanitities of some trace elements in various locations in and around the power plant. The samples will be analyzed for such trace elements as mercury, cadmium, chromium, selenium, arsenic, and about eight to ten other trace elements.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Four Corners Ambient Air Monitoring Network

PRINCIPAL INVESTIGATOR(S):

Dr. D.N. McNelis

SUMMARY:

Objectives: Maintain an air quality monitoring network in the Four Corners area to evaluate the present and future air quality impact of energy-related developments in the Western United States.

Integrate the air quality monitoring data collected by this network with data collected elsewhere.

Approach: A 28-station Hi-Vol network is operated over the Four Corners Region. A 24-hour sample is collected three times per week. Each sample is analyzed for trace elements (Pb, Cr, Cu, Ni, Fe, and Cd), sulfate nitrate, and total suspended particulate. All data are entered into the EPA SAROAD System.

Outputs: Annual summary of data. Quarterly progress reports.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Morphology and Composition of Particulates Emitted by Stationary Sources

PRINCIPAL INVESTIGATOR:

U.L. Miller
U.S. Environmental Protection Agency
Emissions Measurements & Characterization Division
Durham, North Carolina 27711

SUMMARY:

Objective: Determine the morphology and elemental composition of particulate matter emitted by stationary sources using electron optical techniques.

Approach: The analyses will be carried out using transmission and scanning electron microscopy in conjunction with electron diffraction, electron microprobe measurements, and advanced image analysis techniques.

Current Plans/progress: Sources under study include oil-fired and coal-fired power plants, incinerators, and basic oxygen furnaces.

Coal-Fired Power Plants

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

EPA Colstrip

PRINCIPAL INVESTIGATOR:

G.T. Monice
U.S. Department of Commerce
Environmental Research Laboratories
Boulder, Colorado 80302

SUMMARY:

Objective: Monitor and characterize atmospheric aerosol content downwind of the Colstrip, Montana, coal-burning power plant.

Current Year Plan: Measure aerosol content at Colstrip before and after the power plant begins operation.

Progress Report: The aerosol content at Colstrip was monitored for two, two-week periods in the spring and fall of 1976, generating a clear air baseline for future measurements.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Cloud and Precipitation Modification Effects of Pollutants from Energy Production

PRINCIPAL INVESTIGATOR:

Dr. R.F. Oueschel
U.S. Department of Commercy
Atomspheric Physics & Chemical Laboratory
Boulder, Colorado 80302

SUMMARY:

Provide information on the size, shape, and chemical compostion of atmospheric pollutants from power plants under varying moisture and background-pollution conditions. Develop criteria by which to assess their impact on the cloud and ice nuclei budget and solar and terrestrial radiative fluxes. Provide recommendations for control measures to minimize detrimental environmental effects.

Measure in-situ by aircraft 1) primary (flyash) and secondary (gas-to-particle converted) aerosols, 2) gases that lead to particle formation, 3) infrared terrestrial radiation. Collect additional aerosol samples for delineating the parameters that determine cloud nucleating and radiative effects, viz., particle size and size distribution, shape, and elemental composition. Independently, determine the cloud and ice nucleating portion of the aersol.

1. The Four Corners, N.M., power plant neither destroys nor creates ice nuclei that act by the deposition and/or condensation followed by freezing mechanisms. 2. In the same plume, a gas-to-particle conversion mechanism creates cloud condensation nuclei at a rate of from 10 to the 14th power to 10 to the 16th power per second. 3. During the combustion process, water soluble sulfates and chlorides condense at the surface of flyash particles. 4. Infrared (8-14 microns) properties of plume effluents are: transmissivity equals 0.82 plus or minus 0.01; extinction coefficient equals 0.99 plus or minus 0.04 per kilometer; cooling rate equals 0.64 plus or minus 0.1 centigrade per hour.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Mechanisms of Photochemical Reactions in Urban Air

PRINCIPAL INVESTIGATOR:

Prof. J.N. Pitts
University of California
Statewide Air Pollution Research Center
Riverside, California 92507

SUMMARY:

Reactions of possible importance in photochemical air pollution are being investigated with a variety of techniques over heterogeneous vapor, liquid and solid systems. Research includes selected aspects of a photochemistry, spectroscopy, kinetics and mechanisms of photo-oxidation of common atmospheric pollutants, including PAN, oxides of nitrogen, monocyclic aromatic hydrocarbons, partially oxygenated hydrocarbons such as aldehydes and ketones, alkylating agents including epoxides, hydrocarbons and lactones, and polycyclic organic hydrocarbons. Long path (20-40M) ir and uv techniques are used to identify unstable intermediates and products in the ppm ranges. Chemiluminescent reactions of ozone with olefins and organic sulfides are being investigated to determine emission intesities and the nature of the reaction processes. Applications of this phenomenon to improve air pollution monitoring instrumentation are being studied. The o-nitrobenzaldehyde chemical actinometer orginally developed on this project has been field tested by federal and state agencies and continues to be evaluated and improved. Information derived from laboratory studies cited above is being applied to the design and execution of cooperative smog chamber studies of synthetic and real atmospheres. It is also being used to derive more accurate hydrocarbon and oxygenated hydrocarbon reactivity scales useful in consideration of exhaust control devices and fuel modifications.

ORGANIZATION:

U.S. Energy Research and Development Administration
Biomedical and Environmental Research Division

TITLE:

Trace Contaminants from Fossil-Fuel Power Stations - Dose to Man from Toxic Trace Elements in Stack Emission

PRINCIPAL INVESTIGATOR:

R.C. Ragaini
University of California
Lawrence Livermore Laboratory
P. O. Box 808
Livermore, California 94550

SUMMARY:

The objective of the study is to evaluate the trace element dose to man by inhalation of stack emissions from fossil-fuel power plants. Particulate and gaseous samples are being collected from the stacks at the Huntington Canyon (Utah) and Four Corners (New Mexico) power plants. The particle-size distributions and gaseous fractions of the trace elements are being measured. Further in-plume measurements will be made to determine downwind physical and chemical changes of the various trace elements. Elements of major interest include Pb, Hg, Cd, As, Se, Be, Cu, Zn, Sb, Ag, Na, and K. Other elements which will be analyzed include Al, Cl, Br, I, Ca, rare earths, Ba, Mg, Mn, Ti, V, Cr, U, Th, Ra, Sc, and Fe, among others.

Results: Coal, flyash, bottom ash, and gas samples have been collected from Huntington Canyon. They are currently being analyzed. Elemental analysis procedures used have already been published in 2 reports. A sampling program is underway at Four Corners.

ORGANIZATION:

U.S. Energy Research and Development Administration
Biomedical and Environmental Research Division

TITLE:

Chemical Reaction Kinetics of Combustion Products

PRINCIPAL INVESTIGATOR:

L.A. Rancitelli
Battelle Memorial Institute
P. O. Box 999
Richland, Washington 99352

SUMMARY:

This program will develop a model with which, when given inputs of chemical composition of coal, combustion temperatures and conditions, fuel gas temperature, and pressure profiles, precipitation devices and stack conditions, can predict the composition of the flue gas and the chemical and physical form of the emitted aerosol particles. The model will employ thermodynamic and kinetic information such as the free energy of formation, diffusion and reaction rate constants, temperature of combustion, and the chemical composition of both the coal and flue gas to describe formation mechanisms of solid and gaseous products. It will include both laboratory and power plant measurements to verify kinetic and specific reaction pathways. The study will be initially directed as describing and modeling the conditions in the 1400 megawatt coal-fired electric generating plant at Centralia, Washington.

Results: Although this is a new program, related work has been done to begin to characterize the effluents from the Centralia fossil fuel plant, and the deposition pattern of selected elements on the surrounding biota. This initial study has defined the approximate particle size, chemical composition, relationship of the aerosols, and established the approximate amounts of these materials in the gaseous phase.

ORGANIZATION:

U.S. Environmental Protection Agency
Office of Research and Development

TITLE:

Fly Ash Characterization and Disposal and Studying Water Reuse or Recycling

PRINCIPAL INVESTIGATOR:

S.S. Ray

SUMMARY:

The purposes of this project are to chemically and physically characterize ashes and their waste effluents and to examine fly ash methods for water reuse. Mass balances around several facilities having different boiler systems and coals may be incorporated to determine the difference in ash and effluent characterisitics with variation in boiler design, operation, or coal type. The scope of this project includes summarizing available information on ashes and effluents, wet and dry handling systems, disposal and utilization of fly ash, and methods of treatment for water reuse; characterizing ashes and effluents of several plants; studies on disposal alternatives and specific ash problems; and studies on processes for reusing or recycling wastewater streams from coal-fired power plants.

A report, "Characterization of Ash from Coal-Fired power Plants," was completed and distributed. Sampling programs to determine mass balances around the units have been conducted at two TVA steam plants. In October 1975 a three-day preliminary study was conducted to test procedures, equipment, and personnel at wall-fired unit of Colbert Steam Plant. In August 1976 an eight-day sampling program was conducted on the same unit. Sampling points were the coal scales, pulverizer, mechanical collector and electrostatic precipitator ash hoppers, pyrite hopper, inflow water, and sluice waters for fly ash, bottom ash, and pyrites. For the second study the gas stream, both before and after the electrostatic precipitator, was sampled in addition. These samples have now been chemically and physically analyzed. In July 1977 a similar study was conducted at a tangentially-fired unit of Kingston Steam Plant.

Plans for this fiscal years are to chemically and physically analyze the samples from the Kingston Steam Plant study; to complete a milestone report on results of the Colbert Steam Plant study; to summarize methods of treatments of water reuse; to summarize methods for disposal and utilization of fly ash; and to study processes for reusing or recycling wastewater streams from coal-fired power plants.

Coal-Fired Power Plants

ORGANIZATION:

U.S. Environmental Protection Agency
National Environmental Research Center

TITLE:

Continuous Monitor of Mass Concentration of Particulate
Emission from Stationary Sources

PRINCIPAL INVESTIGATOR:

Dr. E. Reisman
Pilco Ford Corporation
3825 Fabian Way
Palo Alto, California 94303

SUMMARY:

The objective of the program is to construct an optical instrument that is capable of making measurements of mass concentration in times approaching real time. The technique makes use of the fact that the wavelength dependence of opacity varies with the size of the particles in the effluent. The instrument makes transmission measurements at several wavelengths from absorption bands in the visible and IR. The data are fed into a computer that has been programmed for a particular type of site. The program contains information on the optical indices of the particles as a function of wavelength, the form of the particle size distribution function typical size ranges, etc. The computer makes a best fit of the optical data by adjusting the parameters of the size distribution function and computes the mass concentration. Since the computations occur very rapidly, the results are available in almost real time. The current system used time share but future units will use an on-board minicomputer.

The program will be accomplished in two phases. The first phase will involve the construction of a breadboard unit that will be checked out in the laboratory with controlled dust chambers and cells. The second phase involves the packaging of a field worthy unit which will be tested at a coal burning power plant and at a Portland cement plant. Concurrent probe measurements will also be made.

ORGANIZATION:

Public Service Company of New Mexico

TITLE:

NO_X Reduction Studies for a Coal Fired Steam-Electric Power Plant

PRINCIPAL INVESTIGATOR:

J.M. Robinson
Public Service Co. of N.M.
P.O. Box 2267
Alburquerque, New Mexico 87103

SUMMARY:

Familiarization with unit characteristics and normal operational procedures to ascertain operational capability for control of air and fuel flows, air register adjustment, etc. Probe and fly ash samplings systems shall be designed and tested. Testing shall be performed over the load range to measure NO, CO, and excess O_2 concentrations in the exhaust. O_2 levels shall be varied to determine the sensitivity of NO, CO and carbon content of the ash to excess O_2. Modified operating modes shall be tested and low NO firing modes will be recommended and verified. The main sample point shall be upstream of the air preheater and precipitator, but NO concentrations shall be checked both up and down stream from the precipitator.

ORGANIZATION:

U.S. Energy Research and Development Administration
Biomedical and Environmental Research Division

TITLE:

Environmental Effects of Solid Waste as a Supplemental Fuel

PRINCIPAL INVESTIGATOR:

H.R. Shanks
Iowa State University of Science and Technology
Ames Laboratory
University Station, Box 14A
Ames, Iowa 50010

SUMMARY:

This research project is a systematic experimental study to determine the environmental effects of burning solid waste as a supplemental fuel with coal. The study is being carried out in a power plant which the city of Ames, Iowa, has recently modified so that solid wastes and coal can be burned for electrical power generation. Data collected before modification of the power plant provide "baseline" values for the emission of both stoker fired and pulverized coal tangential burner fired steam generators and allow comparison with data obtained from the units when solid waste is included as fuel. Items analyzed and quantified include particulate matter, stack gases, fuel input and bottom ash such that a material balance can be performed on each boiler under various loading conditions.

Results: Sampling ports have been installed at a number of points in the power plant. Baseline samples have been obtained on one unit and on the ash pond. These samples are presently being analyzed by several analytical techniques.

ORGANIZATION:

U.S. Environmental Protection Agency
Office of Energy Mineral and Industry

TITLE:

Regional Atmospheric Transport of Coal-Fired Plant Emissions

PRINCIPAL INVESTIGATOR:

U. Sharma
H.C. Jones
L.M. Reisinger

SUMMARY:

The sulfur dioxide/sulfate issue requires development of a scientific data base to delineate regional effects of coal-fired power mechanisms of long-range transport of emissions. A long-range complex is being developed and applied to a meso-scale region (approximately 1000 km) centered over the Tennessee Valley watershed. Among factors being considered are advection by wind field, air parcel trajectories, diffusion by atmospheric turbulence, source/sink mechanisms and chemical transformations. A regional SO_2 emissions inventory has been acquired and maintained by continual updating. Field studies were conducted in spring 1976 and summer 1977. Data are being analyzed and a regional atmospheric transport model is being developed. Some findings have been reported in internal reports and professional journals. Major milestone report is due in September 1978.

ORGANIZATION:

U.S. Environmental Protection Agency
Office of Research and Development

TITLE:

Air Monitoring of Energy Resource Development Related Toxic Substances and Suspended Particulates in the Southwest United States

PRINCIPAL INVESTIGATOR:

Dr. M.D. Slade
UTE Research Laboratory
Fort Duchesne, Utah 84026

SUMMARY:

Establishment of baseline data on selected hazardous air pollutants and also the coninuous monitoring of these pollutants in areas of existing energy related activities.

The contractor will provide environmental monitoring and analytical services to develop a data base on airborne hazardous substances and suspended particulate material for the purpose of assessing the environmental impact of energy resources development activities in the Southwestern United States (emphasizing the four corners area).

Sampling stations are to be maintained by the contractor. Filters from the network are to be collected and analyzed by atomic absorption spectroscopy for trace elements using appropriate EPA methods.

Quarterly, annual and a final report will be submitted in accordance with "Interim Specifications for Or and M Grant, Contract and In-House Reports."

ORGANIZATION:

U.S. Environmental Protection Agency
Office of Research and Development

TITLE:

Field Testing of the Barringer Cospec II as an Area Monitor

PRINCIPAL INVESTIGATOR:

R.B. Sperling
Environmental Measure, Inc.
San Francisco, California

SUMMARY:

Objectives - To determine the relative accuracy of an EPA-Furnished Barringer Correlation Spectrometer (COSPEC) II system as a perimeter montior for Sulfur Dioxide (SO_2), compared to Method 6 in-stack measurements. The test will be conducted at a coal-fired power plant. Use of the remote sensor as a ground-mobile monitor for surveillance of stationary sources will be evaluated.

Approach - A mobile laboratory equipped with a power supply and data recording equipment will be used to transport the remote sensor around the power plant. The vertical viewing COSPEC will measure SO_2 burden; wind data will be gathered simultaneously with the plume measurements. Together the two sets of data will be used to calculate emission rates of SO_2. The results will be compared directly with instack SO_2 emission rate data.

Current plans - The study site will be the San Juan generating station of the Public Service Company of New Mexico, located in northwest New Mexico. A minimum of five plume cross-sections will be made each day by the COSPEC for 10 days: an average of three in-stack measurements will be conducted each day.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Comparative Toxicologic Evaluation of Emissions from Fuel Combustions

PRINCIPAL INVESTIGATOR:

U.E. Stara
National Environment Research Center
5555 Ridge Avenue
Cincinnati, OH 45213

SUMMARY:

Objectives include determination of relative toxic potential of emissions resulting from use of various fuels, fuel additives, and control devices in automotive, diesel and aviation mobile sources and in stationary fuel combustion systems. The test data are used in process of developing criteria which are used for setting the environmental pollution standards; and in the process of development of standarized toxicological tests protocols. Serial experiments involving exposure to selected biological models in vivo and in vitro to raw and irradiated whole emissions or components thereof generated by combustion process using chemicophysical characterization of emissions (gaseous and particulate components) and multidisciplinary quantitation of associated biological effects are conducted. In 1972, this approach has been used for the comparative evaluation of emissions and bioeffects resulting from the use of reference fuel with and without a test additive. In FY 73, studies will be conducted on diesel fuel, further gasoline and additives testing, and the incorporation of emission control devices (catalytic converter) using improved facilities and systems. Essential task elements of the project include supportive aerometry (atmosphere monitoring and characterization); engineering (operation, exhaust generation, dilution, delivery, and control systems); and multidisciplinary biological testing approach including biochemical, pathological, and physiological investigations.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Power Plant Plume and Sulfate Study in Complex Terrain

PRINCIPAL INVESTIGATOR:

J.L. Swift
Goemet Incorporated
15 Firstfield Road
Gaithersburg, Maryland 20760

SUMMARY:

Objectives: (1) Creation of reliable data describing atmospheric behavior of sulfur oxide and nitrogen oxide emitted from a specific large power plant in complex terrain; (2) Appraisal of current knowledge of plume behavior under similar conditions; (3) Improvement of capabilities for predicting such behavior.

Approach: (1) A six-month literature survey will be conducted of current knowledge of atmospheric behavior of plumes from tall stacks in complex, terrain, including conservative dispersion and sulfate transformation; plus an appraisal of the adequacy of available modeling techniques for predicting such behavior. (2) Field measurements will be conducted for a year using fixed and mobile ground plus airborne monitoring at the 700 MW coal-fired Clinch River Power Plant in the Appalachian Mountains at Carbo, Virginia. Parameters observed continuously will include meteorology; NO_x and SO_x emissions; concentrations over time and space of NO_x, SO_2, sulfates and O_3 in the plume. (3) Improved modeling techniques for describing plume behavior in complex terrain and sulfate transformation will be developed upon data and the Clinch River literature survey.

ORGANIZATION:

U.S. Environmental Protection Agency
Office of Research and Development

TITLE:

Chlorinated Compounds in Coastal Power Plant Cooling Waters

PRINCIPAL INVESTIGATOR:

J.F. Thomas
University of California
School of Engineering
Berkeley, California

SUMMARY:

The objective of the proposed research is to determine the quantity, nature and persistence of chlorine residuals in cooling waters from coastal power plants that have been treated with chlorine for slime control. Cooling water intake, in plant cooling water and cooling water discharges will be sampled during chlorine treatment for gross chlorine residual determination at several sites. At a limited number of sites an attempt will be made by extraction, concentration gas chromatography and mass spectrometry to quantitate and identify important components of the chlorine residual under conditions representative of the discharge.

ORGANIZATION:

U.S. Environmental Protection Agency
Office of Research and Development

TITLE:

Comparative Toxicologic Assessment of Fly Ash from Western vs. Easter Coals

PRINCIPAL INVESTIGATOR:

C.E. Ulrich

SUMMARY:

The present contract was originated in order to increase the data base concerning the toxicological properties of fly ash from coal fired power generating facilities. Limited data is available from those using Eastern United States and almost none from those using Western coal sources. The study was therefore designed to compare the relative toxicological effects of fly ash from a power plant located in the West and using coal from the Powder River region and one from the East burning coal from the Appalachian region.

Approach: Experimental animals will be exposed to an aerosol generated from fly ash collected from the final stage of an electrostatic precipitator. The particles will be first separated according to size to provide fly as particles comparable to those passing through the precipitator and going up the stack. Rats, guinea pigs and cynamolgous monkeys will be exposed 9 months at concentrations varying from threshold levels to near lethal.

Current Plans: The effective date of this contract was June 1, 1976 with a 2-year performance period. Due to problems in stack sampling, a delay resulted in a 6-month extension. Fly ash collection and stack gas collection has been completed. Chemical analysis is partially complete. Animals have been exposed acutely to determine the fly ash concentration to be used during chronic exposure. Chronic animal exposures are planned to begin August 1977.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Basic Environmental Services

PRINCIPAL INVESTIGATOR:

V. Valin
U.S. Department of Commerce
Environmental Research Laboratories
Boulder, Colorado 80302

SUMMARY:

Objective: Conduct an evaluation of the aerosol characteristics in the vicinity of Colstrip, Montana, near a large coal-fired electric generating plant, in order to assess the impact of plant effluents on precipitation patterns in the area and downwind from the plant.

Current Year Plan: Conduct an aerosol sampling program in Montana using an instrumental cloud physics trailer and airborne samples and complete scanning electron microscopic analysis of the collected samples.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Environmental Effect of Utilizing Solid Waste as a Supplementary Power-Plant Fuel

PRINCIPAL INVESTIGATOR(S):

D.A. Vaughan
W.K. Boyd
H.H. Krause
R.B. Engdahl

SUMMARY:

The objective of this project is to investigate the benefits to the environment resulting from the utilization of solid waste as a supplemtary fuel in existing coal-fired power plants.

The approach is to evaluate the gaseous and particulate emission plus the corrosiveness of combustion products as a function of sulfur content of the coal. Experiments will be conducted in an operating power station through cooperation of the City of Columbus, Ohio, and at the Harrisburg (PA) Waterwall Co. Incineration Plant.

Furnace and stack gas and particulate samples will be collected throughout the periods that corrosion probes are inserted at several locations in the heat-recovery passes. These probes will be examined for corrosion attack and deposit composition for various gas and metal temperatures to provide guidance in future utilization of solid waste as a supplementary fuel.

ORGANIZATION:

U.S. Environmental Protection Agency
Unspecified Unit

TITLE:

Particle Chromatographic Analysis of Fly Ash

PRINCIPAL INVESTIGATOR:

Dr. W.R. Wilcox
Clarkson College of Technology
School of Engineering
51 Main Street
Potsdam, New York 13676

SUMMARY:

Particle Chromatograph was invented by the principal investigator for separation of particle mixtures by their surface properties, rather than by density, size electrical properties, etc. We propose to apply this technique to the detailed analysis of fly ash. Without separation, one is only able to obtain an average chemical analysis or the characteristics of a few individual particles. Such detailed characterization should prove useful for pollution control, optimization of boiler design and operation, and analysis of trace impurities. Funding is requested initially only for one year for a feasibility study for separation of fly ash particles. Actual detailed characterization would be performed in the second year.

The long term objective of our proposed program is to utilize our new particle separation technique particle chromatography, in a program of quantitative analysis of the different types of particles found in fly ash from fossil-fuel fired electric power plants. The first year objective is to adapt particle chromatography to the specific task of separating particles of fly ash. Assuming that this is successful in the second year separation and anlysis of representative samples of fly ash will be performed.

Coal-Fired Power Plants

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Impact of Conditioning on Power Plant Emissions Through Controlled Airborne Sampling

PRINCIPAL INVESTIGATOR:

R.E. Williams
University of Denver
Denver Research Institute
University Park
Denver, Colorado 80210

SUMMARY:

Objective: To explore the feasibility of using a captive balloon, capable of carrying an ultra lightweight sampling package, to ascertain the concentration and composition of certain solid, liquid, and gaseous emissions from a fossil fuel power plant. It is anticipated that this sampling scheme would be used to quantify the impact of conditioning on emissions as well as extending mass balance studies and investigating the primary versus secondary aerosol content of stack plumes in areas where periods of rather stable horizontal plum conditions occurs.

Technique: A tethered balloon with multiple, sequential particulate samplers will be used to cross-section and profile an isolated power plant plume collecting only solid particulates during this study. Particulate composition and size distribution will be compared with stack samples and plant operating conditions.

Relevance: The fate of emissions from stacks is not well understood. Attempts using aircraft are not feasibile at low flying altitudes and in proximity to the power plant stack because of the poor spatial resolution (aircraft velocity), and for safety reasons. Optical techniques, such as the transmissometer, give no meaningful data as to changes in plume composition. An in situ sampler can lead to an understanding of how plant operations, e.g., addition of H_2SO_4, lime, etc., can alter emissions with time.

ORGANIZATION:

U.S. Environmental Protection Agency
Office of Research and Development

TITLE:

Mesoscale Sulfur Balance Studies

PRINCIPAL INVESTIGATOR:

Dr. J.W. Winchester
State University of Florida Systems
School of Arts & Sciences
205 Wildwood Drive
Tallahassee, Florida 32306

SUMMARY:

A comprehensive study is being conducted to characterize the occurrence of sulfur in aerosol particles at sampling stations in 14 locations between the mid-continent and eastern seaboard of continental U.S.A. Additional remote stations in marine and continental areas are also being operated to provide important background information. Emphasis is being placed on the concentrations of sulfur in relation to other elements present in the aerosol and on the time variability of these concentrations with a time resolution of 2 hours. Sampling is being carried out continuously at heights from ground level to 30 meters by a unique time sequence filter sampler which has been developed at Florida State University. Additional samples are planned to be taken during intensive periods during the year by cascade impactors at about five of the filter sampling sites, using cascade impactors for determination of the particle size distribution of sulfur and related elements. Elemental analysis is performed using proton induced X-ray emission, a highly sensitive technique permitting both the extremely short 2-hour time resolution on a continuous basis for filter samples as well as the size resolution of particles as small as 0.25 micron diameter by cascade impactors. By means of the combination of sampling techniques, the impact of fossil fuel combustion and other anthropogenic sources of sulfur on the natural characteristics of the atmosphere may be precisely determined.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Formation of Atmospheric Aerosols

PRINCIPAL INVESTIGATOR(S):

Professor K.T. Whitby
D.B. Kittelson
B.K. Cantrell

SUMMARY:

Aerosol size distributions have been measured in the St. Louis area as part of EPA's Project MISST using aircraft and ground based self-contained mobile laboratories. These measurements were made with a group of collaborators so that a complete array of chemical, physical, and meteorological measurements were obtained on a coal fired power plant plume. The University of Minnesota's portion of the project included aerosol measurements aboard an aircraft and the operation of a mobile van on the ground under the plumes.

This mobile van was also operated on freeways in the Los Angeles area during October 1976 as part of an EPA sponsored project to study sulfur aerosols on roadways.

Much of the work during the next project year will be analysis and reporting of the large amount of data obtained during the past several years. Analysis is being directed toward obtaining aerosol growth rates in the plumes, aerosol nucleation rates in the plumes and surrounding distributions. Laboratory work toward the development of a continuous instrument for the measurement of aerosol sulfur is also being partially supported by this project.

ORGANIZATION:

U.S. Department of the Interior Office of Water Research and Technology

TITLE:

Geochemical Controls on Trace Element Concentrations in Natural Waters of a Proposed Coal Ash Landfill Site

PRINCIPAL INVESTIGATORS:

D.O. Whittemore
Kansas State University
School of Arts
Dickens Hall
Manhatten, Kansas 66502

SUMMARY:

Geochemical controls on Cr, Cu, Hg, Pb, As, Se, Zn, and Cd concentrations will be determined for natural waters of a proposed ash storage landfill site accompanying a coal fueled power plant to be built in northeast Kansas. The study is the first step in evaluating the effect on water quality caused by the large amounts of trace elements concentrated in the ash or volatilized during the burning of the coal when the plant is operative.

The present ranges and temporal variations of trace element concentrations will be determined in precipitation, surface, and ground waters in the drainage basins of the proposed coal ash landfill site and an adjacent small stream. Analyses of chemical constituents and properties of soils and bedrock in the two drainage basins will be made and their controls on the addition, removal, and movement of trace elements evaluated and compared. Models of the transport and mass balance of the trace elements in the hydrologic cycle will be prepared.

The expected amounts and fates of trace elements which will be introduced into the study are by the coal burning power plant and its ash storage landfill will be estimated from the results obtained and from existing analyses of coal and coal ash.

ORGANIZATION:

U.S. Environmental Protection Agency
Office of Research and Development

TITLE:

Coal-Fired Power Plant Impact on Terrestrial Ecosystems - Lacynge Plant Vincinity - Kansas and Missouri

PRINCIPAL INVESTIGATOR:

Dr. A.L. Youngman
Wichita State University
School of Liberal Arts
1845 Fairmont
Wichita, Kansas 67208

SUMMARY:

Objectives: To evaluate the influence of stack emissions from a new coal-fired electric generating plant on the surrounding rural-agricultural ecosystem, based especially on trace element analysis of ecosystem components. By employing a team of biologists and geologists we will seek correlations between air quality and biosystem structure including trace element patterns in producer and primary consumer organisms. Chemical analyses for trace elements will be accomplished by means of both neutron activation and atomic absorption spectrophotometric procedures. Progressive changes during the first three years following initiation of power plant operations will be compared with the conditions that existed prior to power plant operation. Baseline conditions have been established for biosystem composition (native and agricultural plants, insect grazers and small mammals) and for air quality (particulates, sulfur dioxide, and nitrogen oxides). Chemical analysis of soils and organisms collected during the baseline phase is currently in progress, with most of the data expected by June, 1978. An expansion of current air and biological sampling programs is planned along with incorporation of aerial survey and meteorological data collection.

ORGANIZATION:

U.S. National Science Foundation
Division of Advanced Environmental Research & Technology

TITLE:

Sources, Transformations, and Specification of Atmospheric Pollutants

PRINCIPAL INVESTIGATOR:

W.H. Zoller
University of Maryland
School of Arts and Sciences
College Park, Maryland 20742

SUMMARY:

This is a continuation of work under Grants GI-36338 and ESR-75-02667 on the trace elements and polycyclic aromatic hydrocarbons in size-graded particulates emitted by power plants (coal-and oil-fired) municipal refuse and sewer-sludge incinerators, automotive traffic, airports, and the rural background. The objective is to identify sources of toxic elements and to trace the origins of ambient particulates. A second objective is to elucidate certain aspects of homogeneous gas reactions in polluted air and to determine the conditions that control ozone formation in power-plant and industrial plumes.

This grant extends the study to the combustion of refuse-derived fuel and to industrial sources represented by steel-making, petroleum refining cement manufacture, and non-ferrous smelting. Trace elements are analyzed by neutron activation and atomic absorption. Polycyclic aromatic hydrocarbons are measured in the particulate and gas phases. Studies in the meterological forecasting of stagnation periods will assist in evaluating the significance of the source emissions.

Studies of rainfall pH will attempt to correlate the acidity of rain with the chemistry of power plant emissions.

Aircraft sampling will be continued to elucidate the factors controlling the appearance of ozone bulges in power plant and industrial plumes by coordinated measurements of ozone, hydrocarbons, nitrogen oxides, carbon monoxide, humidity, condensation nuclei, and temperature.

Coal-Fired Power Plants

ORGANIZATION:

Electric Power Research Institute

TITLE:

Nature of Effluents from a Large Coal Power Plant and Its Interaction with The Atmosphere

PRINCIPAL INVESTIGATOR:

University of Washington
Graduate School
C301 Health Sciences Building
Seattle, Washington 98105

SUMMARY:

Work to be performed under this contract will be concerned with atmospheric emissions from the Centralia Coal-Fired Power Plant (CPP) and their effects on the atmosphere. The principal objectives of the study are: 1) To determine the nature, concentration, and size distribution of the particles in the atmosphere emitted by CPP. 2) To determine the changes in the nature, concentration, and moves through the atmosphere. 3) To investigate the emission, transport, and conversion of sulfur compounds emitted by CPP and their ultimate removal from the atmosphere. 4) To determine the effects of the particles from the CPP on cloud and precipitation processes. 5) To investigate the mechanisms by which particles from the CPP are removed from the atmosphere.

ORGANIZATION:

Electric Power Research Insititute

TITLE:

Measurement of Atmospheric Sulfates

PRINCIPAL INVESTIGATOR:

Radian Corporation
8500 Shoal Creek Blvd.
Austin, Texas 78766

SUMMARY:

The project provides for development, laboratory validation, and initial field testing of a sampling method to distinguish between sulfuric acid mist and particulate sulfates. The literature will be searched to identify highly sensitive methods for collecting and analyzing sulfur dioxide, sulfates, and particulates from ambient air. Existing gas mixing equipment will be modified and new filters and condensors for sulfur dioxide and sulfur trioxide, and particulates will be built. After satisfactory laboratory checkout, field verification will be performed. To determine more accurately the chemical nature of sulfur compounds emitted to the atmosphere by fossil-fueled power plants, a sampling technique which discriminates between sulfuric acid and sulfate solids is needed.

Coal-Fired Power Plants

ORGANIZATION:

Electric Power Research Institute

TITLE:

Development of an Efficient Sampling System for Organic Combustion Effluents

PRINCIPAL INVESTIGATOR:

Battelle Memorial Institute
505 King Avenue
Columbus, Ohio 43201

SUMMARY:

The objective of work performed under this contract is to develop a simple and efficient sampling **device** for the collection of organic components of stack gases from combustion sources and other energy related activities.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Interpretation of Data from Biogenic Sulfur Field Studies/Mist Technical Support

PRINCIPAL INVESTOGATOR(S):

Unknown

SUMMARY:

During the contract period the contractor will provide technical services as directed by the Project Officer through task orders. Such services will include but are not limited to: (1) prediction of size, shape and direction of power plant and urban plumes, (2) planning assistance (site selection and experimental design), (3) surface and vertical profile measurements, (4) measurement of verticle fluxes of pollutants, (5) calculation of wind fields and trajectories, and (6) preparation of appropriate data and interpretive reports. These services are expected to require approximately 700 man-hours during the contract period, but the contract should provide for the purchase of additional services in increments of 325 man-hours if they are needed. The contractor shall provide equipment, materials, and travel that may be required to perform assigned tasks.

ORGANIZATION

Pennsylvania Electric Company

TITLE:

West Trace Element Program

PRINCIPAL INVESTIGATOR:

Radian Corporation
8500 Shoal Creek Blvd.
Austin, Texas 78766

SUMMARY:

Purpose: To study trace element removal from fossil fueled power generating station. Objectives: (1) To take advantage of mutual sharing of R&D funds with other utility companies in order to obtain maximum benefical results for money expended. (2) To determine selected trace element removal efficiency of horizontal module at Monroe Generating Station. (3) To determine selected trace element removal efficiency of vertical module at Mchave Generating Station. (4) To collect and analyze selected trace elements directly from stack gases by means of wet electrostatic precipitator system.

ORGANIZATION:

U.S. National Science Foundation
Division of Engineering

TITLE:

REMOTE DETECTION OF STACK POLLUTANTS BY MEANS OF CONCENTRATION MODULATION

PRINCIPAL INVESTIGATOR:

F.S. Barnes
Univ. of Colorado
School of Engineering & Applied Science
1200 University Avenue
Bolder, Colorado 80302

SUMMARY:

The purpose of this research is to develop a system for making remote measurements of photochemical pollutants in effluent from stacks. There is currently a variety of techniques for remote-sensing of these pollutants. These include IR spectroscopy, Raman spectroscopy, optical heterodyne techniques, etc. However, all these techniques suffer from high optical noise due to background radiation and stack emissions. It is proposed to use an ultraviolet beam to modulate the concentration of these pollutants by means of photochemical reactions. This provides modulated infrared emission signals which can be selectively detected against unmodulated optical noises by means of simple signal-processing techniques. The improvement of signal to noise ratios due to this method is calculated to be a hundred times to about 10 to the 4th power times, depending on the pollutant species under measurement and the degree of cloudiness in the sky. The proposed program will proceed in three parts: (1) Completion of the analysis and design of the pollution detection system; (2) Construction and laboratory testing of an instrument; (3) Testing on remote sites.

ORGANIZATION:

U.S. Environmental Protection Agency
National Environmental Research Center

TITLE:

Development of GFC Instruments of Gaseous Pollutant Measurements

PRINCIPAL INVESTIGATOR:

E.R. Bartel
Science Applications Inc.
1200 Prospect Place
LaJolla, California 92037

SUMMARY:

Objective: To design, fabricate, field test and reduce the data for two infrared Gas Filter Correlation instruments for measurement of extended area stationary source gaseous pollutant emissions. One instrument will operate in the up-looking mode (single-ended, passive) to sense ambient temperature sulfur dioxide against the cold sky background. The second will operate in the open-path mode (double-ended, active) to sense sulfur dioxide, hydrogen sulfide, and vinyl chloride monomer at ground level. The design goals for each instrument are: Sensitivity: 50 ppm-meters (nominal); Dynamic Range: Two order of magnitude; Time constant: Variable from 1 to 60 seconds.

Approach: To measure the infrared radiation emitted or absorbed by the pollutants and correlating this radiation by alternately passing it through a gas cell containing a sample of the specific pollutant to be detected and a reference cell which is transparent. This is the GFC technique which provides a highly specific measurement in the presence of interfering species. The passive, up-looking instrument will measure SO_2 at 4.0 micron. The active instrument will measure SO_2 at 8.6 micron, H_2S at 7.9 micron, and VCM at 10.9 micron using an infrared source and a retroreflector.

Plans: To build and calibrate the two instruments over the next nine months and then to field test them in the vicinity of a coal-burning power plant.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Field Evaluation of Source Sampling Technology for Trace Elements and Pom

PRINCIPAL INVESTIGATOR:

R.L. Bennett
U.S. Environmental Protection Agency
Environmental Sciences Research Laboratory
Durham, North Carolina 27711

SUMMARY:

The objectives of this task are to test collection methods for trace elements and organic materials from various types of sources. The collected sample will be used to help characterize the sources.

Samples are being collected on various types of filter material under various conditions. Both solid sorbent and impingers are being used for condensibles and organics.

Currently, samples are being collected at oil-fired and coal-fired power plants and municipal incinerators.

Coal-Fired Power Plants

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Report on Sampling and Analysis Techniques for Condensable Emission From Stationary Sources

PRINCIPAL INVESTIGATOR:

R. L. Bennett
U. S. Environmental Protection Agency
Environmental Sciences Research Laboratory
Durham, North Carolina 27711

SUMMARY:

The objective of this task is to prepare a review report on the progress of collection and analysis of vaporous emissions from stationary sources.

The task will include a careful study of the work on collection and analysis method for toxic organic and inorganic compounds that have vapor pressures sufficiently high so that filtration does not yield efficient collection. Included in this group are compounds of arsenic, selenium, lead and mercury.

Currently, only information gathering is in progress. Industries under study are oil-fired power plants, coal-fired power plants, basic oxygen furnace and municipal incinerators.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Detailed Organic and Inorganic Analysis or Particulate Emissions from Selected Sources

PRINCIPAL INVESTIGATOR:

R.L. Bennett
U.S. Environmental Protection Agency
Environmental Sciences Research Laboratory
Durham, North Carolina 27711

SUMMARY:

The objective of this task is to obtain chemical analyses on particulate samples of the emissions from various preselected source industries. The analysis will be for both organic and inorganic compounds.

The samples will be collected by various filters and special solid sorbent systems. The analyses will be x-ray fluorescence for trace element and IR and other methods of spectroanalysis for the organic content.

Currently, emission samples from oil-fired and coal-fired power plants are being analyzed.

ORGANIZATION:

U.S. Energy Research and Development Administration
Biomedical and Environmental Research Division

TITLE:

Biogeochemical Cycling in Aquatic Ecosystems of Trace Elements in Coal

PRINCIPAL INVESTIGATOR:

B.G. Blaylock
U.S. Energy Research and Development Administration
Environmental Sciences Division
P. O. Box E
Oak Ridge, TN 37831

SUMMARY:

It is expected that with increases in both energy demands and reliance on domestic supplies of fossil fuels, coal consumption and resultant releases of trace elements associated with coal to the environment will increase. The objective of this research is to examine the biogeochemical cycling of vanadium and nickel in a reservoir typical of the Southeast U.S. These 2 potentially toxic trace elements occur in relatively high concentrations in effluents from coal combustion, coal extraction, and coal conversion techniques. Specific objectives are: (1) to determine the distributional patterns of V and Ni in biotic and abiotic components of this reservoir ecosystem. This will include identification and quantification of the important pools of these 2 trace elements in this sytem; (2) to examine those environmental variables (e.g., pH, Eh) which govern the mobility of these 2 trace elements in aquatic systems; (3) to investigate food chain kinetics of V and Ni and their influence on trace element concentrations at high trophic levels in the reservoir. The research includes identification of critical pathways and determination of transfer coefficients for food chains leading to man. The goals of this program will be accomplished through integrated field and laboratory research. The field research site is an embayment of Melton Hill Reservoir which receives runoff from Walker Branch Watershed, a forested catchment.

ORGANIZATION:

U.S. Department of the Interior

TITLE:

Environmental Evaluation of Municipal Refuse as an Energy Resource

PRINCIPAL INVESTIGATOR:

W.I. Campbell
U.S. Department of the Interior
Bureau of Mines
College Park, Maryland 20740

SUMMARY:

The objective of this project is to evaluate the possible environmental impact of using the combustible fraction of municipal refuse as an energy supplement. Trace elements of refuse will be identified and their pollution potential compared to those obtained from coal. The distribution of potentially toxic elements in combustion gases and the ashes of combustion will be determined. The potential for leaching pollutants from ash landfills will also be assessed.

ORGANIZATION:

Northeast Utilities Service Company

TITLE:

Laser Remote Monitoring of Smokestack Emissions

PRINCIPAL INVESTIGATOR:

R.K. Change
Yale University
School of Engineering
206 ELM
New Have, Connecticut 06520

SUMMARY:

This research grant is for one year to pursue laser technology for use in the remote measurement of sulfur dioxide and small particulates that might be emitted from a power plant smokestack. In this phase, work would be directed towards determining the practicality and effectivesness of this remote instrumentation. Follow-on work could include the construction of a prototype instrument for field testing. In addition some time will be devoted to determining if the device proposed may also be used to measure air quality of ambient air.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Performance Criteria for Opacity Measurements in Oil-Fired Power Plants and Portland Cement Plants

PRINCIPAL INVESTIGATOR:

W.D. Conner
U.S. Environmental Protection Agency
Environmental Sciences Research Laboratory
Durham, North Carolina 27711

SUMMARY:

The objective of this task is to determine criteria for opacity measurements at oil-fired power plants and Portland cement plants.

Performance and design specifications for in-stack transmissometers for measurement of the opacity of emissions from oil-fired power plants and Portland cement plants are evaluated. The study involves experimental and theoretical evaluations of the effects of the emissions and instrument design specifications on transmissometer performance.

The study has been completed and a draft report has been prepared and is being reviewed.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Field Testing - Application of Combustion Modification to Control Pollutant Emissions from Power Generation Combustion Systems

PRINCIPAL INVESTIGATOR(S):

A.R. Crawford
W. Babtok
E.H. Manny

SUMMARY:

The purpose of this study is to field test power generation combustion equipment including utility boilers, gas turbines, and stationary I. C. engines. Emphasis will be placed on utility boilers firing coal, but the study will include tests of gas- and oil-fired boilers and boilers capable of firing two or more fuels simultaneously. Tests with simultaneous firing of waste and fossil fuels shall also be included.

Emissions to be measured are oxides of nitrogen, oxides of sulfur, hydrocarbons, carbon monoxide, carbon dioxide, oxygen, opacity, sulfates, nitrates, particulate (mass and size distribution), POM, and trace elements. The effect of combustion modification on air pollutant emissions and combustion efficiency will be determined. Also, the effect of modified operation on equipment performance (e.g. slagging, fouling, steam temperature control) will be investigated.

One primary goal is to determine the effect of staged combustion in coal-fired boilers on tube wall corrosion rates. Staged combustion combined with low excess air firing is the most attractive combustion modification combination because it is an effective method of reducing NOx and is relatively easy and inexpensive to implement. However, some increases in tube wall corrosion rates occur. The contractor will use three methods for measuring corrosion rates: (1) corrosion probes for an easy, inexpensive, but probably inaccurate method, (2) ultrasonic tube wall measurement which is more costly but should provide an accurate mapping of the furnace tube wall surface, and (3) test panels which will be welded into the boiler tube wall in areas where extensive corrosion is anticipated. The test panels will be removed after a 6 to 12 month period for precise measurements.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Develop and Apply Biological Monitoring Methods

PRINCIPAL INVESTIGATOR:

A.B. Crockett
U.S. Environmental Protection Agency
Environmental Monitoring & Support Laboratory
P. O. Box 15027
Las Vegas, Nevada 89114

SUMMARY:

Objective: Plants, animals, and various indices will be evaluated as to their value as biological monitors and potential for incorporation into operational monitoring networks.

Approach: Soil, vegetation, and small mammals will be collected around a coal-fired power plant and in a highly urbanized area. After a potential monitor has been identified, factors affecting the receptor will be studied to determine its response and usefulness. Domestic livestock will also be evaluated. Plant communities will be studied to determine if existing species diversity indices have value as indicators of pollutant impact. Microorganisms will be evaluated to determine usefulness as indicators of pollutant bioavailability in soil systems.

Output: Complete sampling at 4-Corners Power Plant for soil and vegetation has been carried out and analyses for soil conducted for mercury, lead, cadmium, zinc, selenium, and copper. Plant communities have been sampled for indices evaluation and rats collected in Los Angeles for lead.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Mercury Distribution in Soil Around a Large Coal-Fired Power Plant

PRINCIPAL INVESTIGATOR:

A.B. Crockett
Monitoring Systems Research and Development Division
Environmental Monitoring and Support Laboratory
Las Vegas, Nevada 89114

SUMMARY:

Detailed soil sampling and analyses for mercury residues indicate no significant differences in mercury residue levels within 30 km of a large coal-fired power plant. Other recent data indicated emissions of 589 and 1,372 kg of mercury by a coal-fired power plant and a smelter, respectively, and pose no health hazard relative to air contamination. These data should be considered in making decisions concerning regulation of mercury emissions from coal-fired utilities. In 1974, utility emissions amounted to only 4 percent of the natural degassing mercury loss in conterminous United States.

ORGANIZATION:

U.S. National Science Foundation
Division of HIgher Education in Science

TITLE:

Research Initiation for Minority Institution Improvement - Trace Element Analysis of Air and Water in Industrial Canal Zone Area in New Orleans

PRINCIPAL INVESTIGATOR:

Dr. V.R. Dave
Southern University A & M College
Undergraduate School
New Orleans, Louisiana 70]26

SUMMARY:

This project is aimed at identifying the trace elements and determining their concentration in air and water surrounding the Industrial Canal zone area. Air and water samples will be analyzed for traces of pollutants arising from industrial waste, exhaust gases and smoke. Study of contaminants in water samples from Lake, Industrial Canal and Gulf will be made, to ascertain the presence of vanadium, selenium,iron,mercury sulfur, etc. Gulf water and hence lake water has often been polluted by oil spills from ocean drilling, by various oil companies, and from collision of heavy barges used for transporting crude oil, etc.

X-ray fluorescence analysis provides a very reliable method for elemental analysis, qualitatively as well as quantitatively. This technique involves excitation of X-rays in the constitutents of the sample, by placing it at the center of an annular radio-isotope source of X-rays with sufficiently high energies. Pure Germanium detector enables high resolution study of emitted X-rays characteristic of the constitutents of the sample. The spectrum is stored in 4096 channels of a multi-channel analyzer interfaced with an H-P 2100 mini-computer for on-line data analysis. The computer facilitates on-line subtraction, peak intergration and comparison of the relative intensities of X-rays for multi-elemental analysis of the sample.

ORGANIZATION:

U.S. Environmental Protection Agency
Office of Research and Development

TITLE:

Field Test Beta Gauge

PRINCIPAL INVESTIGATOR:

J.W. Davis
U.S. Environmental Protection Agency
National Environmental Research Center
P.O. Box 12055
Durham, North Carolina 27711

SUMMARY:

A beta gauge for continuous mass monitoring has been developed under contract; there is a European instrument which is commercially available. There is a present need for an available continuous mass monitor. The beta gauge technique appears to fulfill this need, but an extensive field testing program is necessary to establish capabilities and limitations. Arrangements have been made with a local power company to run tests on a controlled stack. Parallel mass measurements will be made using the EPA sampling train. Testing will begin January 1, 1973, and should be completed on the power plant stack by June 30, 1973. It is anticipated that the testing of other types of sources will be made in the future.

ORGANIZATION:

U.S. Energy Research and Development Administration

TITLE:

Evaluation of Pollution from Trace Elements in Coal

PRINCIPAL INVESTIGATOR:

A.W. Deurbrouck
U.S. Energy Research and Development Administration
Pittsburgh Energy Research Center
4800 Forbes Avenue
Pittsburgh, Pennsylvania 15213

SUMMARY:

To determine the levels of potentially harmful pollutants released as combustion products of coal; and, further to determine the benefits that may accrue by removal of high density impurtiies associated with coal.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Use of Lichens as Predictors and Indicators of Air Pollution from a Coal-Fired Power Plant

PRINCIPAL INVESTIGATOR(S):

S. Eversam

SUMMARY:

Two lichen species native to southeast Montana showed reduced respiration rates and algal cell plasmolysis and bleaching when exposed to 0.02, 0.04, and 0.07 ppm SO_2 (geometric means) on a field fumigation site. The major objective of the current project is to collect these same two lichen species to be observed as biological monitors of SO_2 emissions from two coal-fired power plants in Colstrip, Montana. Lichen community information is also being collected in order to detect any changes in epiphytic and soil lichen communities as coal burning proceeds in this area. All the lichen information will be integrated with plant community data gathered by other researchers in the area in order to determine effects of SO_2 emissions (and other coal-burning pollutants) on Ponderosa pine-grassland ecosystems.

ORGANIZATION:

U.S. Energy Research and Development Administration
Biomedical and Environmental Research Division

TITLE:

Characterization of Gaseous Molecular Pollutants Emitted by Energy Generation Sources

PRINCIPAL INVESTIGATOR:

V.A. Fassel
Iowa State University of Science and Technology
Ames Laboratory
University Station, Box 14A
Ames, Iowa 50010

SUMMARY:

The broad objectives of this study are to develop general technologies applicable to the characterization and quantification of gaseous molecular pollutants from coal-related energy sources. Particular emphasis will be placed on the development of multipollutant analytical concepts and on the determination of ultratrace pollutants for which inadequate effort has been devoted in the past. Special attention will be placed on those organic pollutants which are or may be emitted from fossil-fueled energy sources and from coal liquefaction and gasification plants. Many of these pollutants are certainly health hazards, and some already identified are proven carcinogens.

Progress has been made on the determination of high molecular weight organic pollutants in air when they are present as vapors, as particulate matter, or as immobilized species sorbed on particulates. Recovery tests with fluorene, phenanthrene, anthracene and perylene at concentration levels ranging from 3 ppb to 95 ppm in volumes ranging from 3 to 300 liters showed that 100% recovery was achieved. The optical luminescences excited on X-ray irradiation of several polynuclear aromatic hydrocarbons in frozen (77°K) Shopol'skii matrices have been successfully observed.

ORGANIZATION:

U.S. Environmental Protection Agency
Office of Research and Development

TITLE:

Characterization of Effluents from Coal-Fired Utility Boilers

PRINCIPAL INVESTIGATOR:

Dr. H.B. Flora

SUMMARY:

The objectives of this project are to 1) Characterize and quantify the chemical and physical components of coal pile drainage, 2) Assess and quantify the chemical and physical nature of ash effluent after the pH of the ash pond has been adjusted to meet existing standards, 3) Evaluate an ash pond monitoring program to determine the sampling necessary to obtain reliable, representative information, 4) Assess and characterize coal ash leachate on ground water, 5) Evaluate and quantify the chlorinated effluent in the discharge canal of a once-through cooling system, 6) Characterize the gaseous and particulate emissions from two plants with different type units, e.g. cyclone and tangential-fired units, 7) Develop technology to remove priority pollutants, and 8) Verify water chemistry model for specific water treatment needed.

Current progress includes 1) Completing field and laboratory studies on characterizing and treating coal pile drainage, 2) Completing laboratory studies on effect of pH adjustment on the quality of ash pond discharge, 3) Completing field ash pond monitoring and assessment of the ability of the monitoring program to obtain reliable, representative data, 4) Assessment of optimum chlorination schedule to maintain generating unit thermal performance continues, 5) completing of field and laboratory studies on quality of ash pond leachate, and 6) completing field studies and laboratory analyses for characterizing gaseous and particulate emissions from different types of boilers.

Future plans are: Publish milestone reports on tasks 1, 2, 3, 5, and 6 above and begin work on tasks 7 and 8.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Mobile Engine Exhaust Hydrocarbon Analysis Via Chemiluminescence

PRINCIPAL INVESTIGATOR:

Dr. Fontijn
Aerochem Research Labs. Inc.
P.O. Box 12
Princeton, New Jersey 08540

SUMMARY:

The objective of this work is to develop a real-time reactive hydrocarbon analyzer, based on chemiluminescent reactions, to be used for auto exhaust monitoring. To determine the feasibility of such an analyzer a comparison will be made of the chemiluminescence spectra of the reactions of atomic O and atomic O/atomic N mixtures with a number of representative mono-olefinic, acetylenic, aromatic and conjugated double bond (-ienic) hydrocarbons. These reactions will be studied in discharge flow systems. Hydrocarbon-class selective emissions will be selected for further studies which include determination of optimum flow conditions, linearity of response, instrument response to hydrocarbon concentration ratio and limit-of-sensitivity. Interference effects from other species present in auto exhausts and exhaust bag samples, e.g. saturated hydrocarbons, N_2, O_2, H_2O, and CO_2, will also be investigated. It is intended that if adequate interference-free response is obtained a prototype insturment, based on the findings of this work, will be built.

ORGANIZATION:

U.S. National Science Foundation

TITLE:

Ecology and Analysis of Trace Contaminants

PRINCIPAL INVESTIGATOR:

W. Fulkerson
U.S. Energy Research & Development Admisistration
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37831

SUMMARY:

This comprehensive interdisciplinary research program will 1) unify and improve existing air, hydrologic and terrestrial submodels for trace element transport mechanisms: 2) validate the resultant Unified Transport Model and UTM) at several watershed sites, including two in the New Lead Belt in Southeastern Missouri, in collaboration with the University of Missouri-Rolla; 3) complete trace element budget studies at Walker Branch Watershed; 4) determine the exchange coefficients, mobility and biological availability of Cd, Zn, Pb and Cu in contaminated soils, sediments and litter from the New Lead Belt; 5) identify the routes of trophic transfer of these elements in a New Lead Belt watershed; 6) investigate the transport of total and methylated mercury in Holston River-Cherokee reservoir and sites of methylation; 7) develop rapid, simple soil tests for toxic metals by extraction and by bioassay using Aspergillus niger; 8) validate the reliability of microcosm simulations of transport and bioaccumulation by comparisons with field studies; 9) demonstrate the ultimate sensitivity of x-ray fluorescence for quantitative rapid multielement analysis by use of a double monochrometer system; 10) develop multielement isotope dilution spark source mass spectroscopy techniques requiring minimum sample preparations; 11) continue development and application of gas chromatography with microwave emission spectrographic detection; 12) explore the utility of liquid chromatography for characterizing aqueous effluents from coal hydrogenation processes; 13) demonstrated the recovery of Zn, Cd and cyanide from electroplating rinse wastes by solvent extraction; 14) field demonstrate a prototype electrolytic cell for recovering organic and inorganic dissolved lead species from an alkyl manufacturing process waste stream. This is the third year of support.

ORGANIZATION:

Public Service Company of Colorado

TITLE:

Study of Pollution Contribution from Stationary Sources in the Rocky Mountain Area

PRINCIPAL INVESTIGATOR:

J.F. Fuller
University of Colorado
School of Engineering
1200 University Avenue
Boulder, Colorado 80302

SUMMARY:

The objective of this project is to perform a study of pollution contributions from stationary sources in the Rocky Mountain area. The work is performed by undergraduate and graduate engineering students at the University of Colorado. In addition to the classification of pollution contributions by parameters such as fuel consumption, energy production, nature of the source, and nature of the emission constituents; it includes a review of present measurement methods for pollutnat emissions and a study of possible alternative measurement techniques.

Coal-Fired Power Plants

ORGANIZATION:

U.S. National Science Foundation

TITLE:

Emissions from Major Air Pollution Sources and Their Atomospheric Interactions

PRINCIPAL INVESTIGATOR:

G.E. Gordon
University of Maryland
School of Arts and Sciences
College Park, Maryland 20742

SUMMARY:

Particulates from coal-and oil-fired power plants, automotive exhausts, municipal incinerators, continental weathering, and an airport will be analyzed to determine total composition in relation to particle-size range. Total composition will be determined, including the organic fraction and 28 trace elements. Analytical methods will include instrumental neutron activation analysis, atomic absorption, flame emission, x-ray fluorescence, chromatography and other special techniques or organic identification. The fate of pollutants from individual sources will be explored in a preliminary way. Unstable gas-phase reaction species will be studied for the purpose of determining their roles in the formation of secondary gaseous pollutants. Rate constants will be determined for key reactions potentially significant for smog formation.

Coal-Fired Power Plants

ORGANIZATION:

U.S. National Science Foundation Division of Adv. Environmental Research and Technology

TITLE:

Atmospheric Impact of Major Resources and Consumers of Energy

PRINCIPAL INVESTIGATOR:

G.E. Gordon
University of Maryland
School of Arts
College Park, Maryland 20740

SUMMARY:

Particulates from coal and oil-fired power plants, automotive exhausts, and municipal incinerators will be analyzed to determine composition in relation to particle-size range and fuel composition. Composition will be determined, including certain organic components and trace elements. The goal is to define the importance of the named sources as contributors to the particulate load of the ambient atmosphere.

Gaseous emissions and their fate in power station plumes will be studied by aircraft sampling and real-time analysis.

Laboratory gas-phase kinetics studies will be devoted to the reactions of stable and unstable reaction intermediates to determine their roles in the information of secondary pollutants.

Coal-Fired Power Plants

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

St. Louis Waste Co-Firing with Coal Project - Equipment, Facilities and Environmental Evaluation of Meramac Power Plant

PRINCIPAL INVESTIGATOR(S):

P.G. Gorman
L.J. Shannon
M.P. Schrag
D.E. Fiscus

SUMMARY:

As part of an EPA demonstration grant, the City of St. Louis has been processing municipal solid waste and the Union Electric Utility has been firing it as an auxiliary fuel at the Meremac Power Plant. The feasibility of the concept has been demonstrated but more data of a substantive nature is being sought from the program. This procurement is to provide services to fully test and evaluate the refuse preparation and firing processes.

Specifically, this project provides for tests to determine the effects of firing refuse and coal on gases and particles emitted from a 120 MW tangentially fired utility boiler. Tests will be made to investigate the mechanisms which cause a loss in ESP performance. Water pollution tests will be conducted and the emission of potentially hazardous pollutants will be investigated. Testing and engineering analyses will be performed to technically and economically evaluate the refuse preparation and firing processes. Requirements for design of emission control devices will be established and process or equipment modifications necessary to reduce process cost and to increase energy or material recovery will be determined.

CURRENT PROJECTS:
COAL-LIQUEFACTION PLANTS

ORGANIZATION:

U.S.Department of the Interior

TITLE:

Lignite Liquefaction Waste Water - Suitability for Reuse and Clean up for Discharge into the Environment.

PRINCIPAL INVESTIGATOR:

Prof. R.J. Baltisberger
University of North Dakota
School of ARts & Sciences
University Station
Grand Forks, North Dakota 58201

SUMMARY:

The proposed research plan involves laboratory investigations directed at the determination of organic and inorganic contaminants generated in the waste water effluents of a lignite liquefaction pilot plant. Methods will be investigated for the clean up or reuse of the waste water.

Laboratory Investigations Would Employ: (1) Extraction and concentration of the organic contaminants. (2) Gas or Liquid chromatographic separation of the organics, followed by UV of mass spectral analysis. (3) Measurement of the inorganic contaminants by electrochemical or atomic absorption techniques. (4) Water solubility studies of solid waste. (5) Absorption studies using activated carbon, lignite or resin for removal of contaminants.

ORGANIZATION:

U.S. Energy Research and Development Administration

TITLE:

Advanced Analytical Techniques Applied to Coal Conversion

PRINCIPAL INVESTIGATOR:

A.G. Sharkey
U.S. Environmental Research & Development Administration

SUMMARY:

The objective is to apply advanced spectral analytical techniques to, and develop methods for, the solution of problems related to the use of coal. Current programs include (1) determination of the composition of gas, oil, tar, char, and water products from SYNTHOIL, SYNTHANE, COSTEAM, HYDRANE, and other coal conversion processes, (2) studies of the mechanism of aging of coal liquids and the development of inhibitors, (3) investigation of the changes in chemical structure that occur during coal liquefaction under pilot plant conditions, and (4) elucidation of the nature of the sulfur, oxygen, and nitrogen heteroatom species, including organometallic compounds, in coal liquids. Included among the instrumental techniques presently being utilized are chromatography and MS, SEM, NMR, ESR, IR, UV, and laser Raman spectroscopies.

ORGANIZATION:

U.S. National Science Foundation

TITLE:

Matrix-Isolation Time-Resolved Fluorescence & Phosphorescence for Analysis of Carcinogens Produced in Coal Conversion

PRINCIPAL IVESTIGATOR:

E.L. Wehry
University of Tennessee
School of Liberal Arts
W. Cumberland Avenue S.W.
Knoxville, Tennessee 37916

SUMMARY:

The possibility that coal conversion plants will produce significant emissions of chemical carcinogens into the atmosphere is recognized. The need for analytical procedures for the measurement of complex organic mixtures on atmospheric particulates is well known, and the requirements for both sensitivity and resolution are stringent. Dr. Wehry will study the use of matrix isolated luminescence spectrometry for the analysis of such pollutants. He will employ time and spectral resolution for sensitivity enhancement using a mode-locked, cavity dumped laser as a source. Samples of atmospheric particulates will be collected in the vicinity of coal conversion pilot plants and in urban atmospheres in order to provide a basis for the evaluation of laboratory results with real samples.

Coal Liquefaction Plants

ORGANIZATION:

Electric Power Research Institute

TITLE:

Matrix Isolation Analysis of Pollutant Emissions from Coal Conversion and Utilization Processes

PRINCIPAL INVESTIGATOR:

Director of Research
University of Tennessee
Graduate School
W. Cumberland Avenue S.W.
Knoxville, Tennessee 37916

SUMMARY:

The principal objective of the research is to develop and evaluate new analytical techniques for polynuclear aromatic hydrocarbons and their derivatives in the atmosphere. The general analytical approaches to be pursued are matrix-isolation fourier transform infrared spectroscopy, and matrix-isolation fluorescence and phosphorescence spectrescopy. The techniques to be employed should substantially increase the sensitivity and selectivity of present methods, and may eventually lead to a substantial simplification.

CURRENT PROJECTS:
COAL GASIFICATION PLANTS

ORGANIZATION:

U.S. Energy Research & Development Administration

TITLE:

Hazardous and Other Undersirable Elements and Compounds in Supplementary Fuels from Coal.

PRINCIPAL INVESTIGATOR:

A.G. Sharkey
U.S. Energy Research & Development Admin.
Pittsburgh Energy Research Center
4800 Forbes Avenue
Pittsburgh, Pennsylvania 15213

SUMMARY:

The objective is to provide data concerning contaminants in process streams to assist in the design of proper purification procedures for producing environmentally acceptable supplemental fuels. Products from coal gasification and liquefication including gas, oil, tar, water and char are being analyzed for toxic or otherwise hazardous components. Trace elements that possibly are toxic in the vapor form or produce hazardous compounds are determined by spark-source mass spectrometry, neutron activation, atomic absorption, and other techniques. High resolution mass spectrometry, combined gas chromatography-mass spectrometery, fluorescence spectroscopy, and other appropriate spectral techniques are used to determine the composition of the organic material associated with these streams.

ORGANIZATION:

U.S. Dept. of Energy
Division of Biomedical & Environmental Research
1717 H St. N.W.
Washington, District of Columbia 20545

TITLE:

Coal Conversion Trace Elements in Aquatic Ecosystems

PRINCIPAL INVESTIGATOR:

E.W. Gekes
U.S. Dept. of Energy
Environmental Sciences Division
P.O. Box E
Oak Ridge, Tennessee 37831

SUMMARY:

The objective of this research is to evaluate potential adverse impacts to aquatic biota and man of trace elements in aqueous coal conversion effluents. Trace elements released to aquatic systems in sufficient quantities can be toxic to aquatic biota or potentially accumulated by aquatic species to the point where consumption by man may pose a threat to human health. We have analyzed two aqueous process streams from the pilot scale COED coal conversion process (Coal-Oil Energy Development) for 55 elements, using spark source mass spectrometry. In an initial step in assessing the potential toxicity and bioaccumulation in freshwater ecosystems of elements released in coal conversion effluents, we compared observed element concentrations in effluents to concentrations reported toxic to aquatic biota; we then calculated threshold concentration that may cause bioaccumulation in aquatic biota to reach levels not safe for human consumption. We have also compiled a data base from available literature on the toxicity in fresh water of 35 elements measured in coal or coal conversion effluents. This information (comprising 2000 reported toxic concentrations spanning 164 taxa) has been incorporated on computer tape and microfiche for external distribution in the near future.

RESULTS: The preliminary analysis indicated that 19 elements detected in the COED process streams have a toxicity and/or bioaccumulation potential in aquatic systems. Quantification of potential adverse impacts will by necessity be both site-specific and process-specific. However, at this stage in the environmental evaluation of coal conversion technology, this analysis has been useful in defining a set of elements that require detailed study, and has been used to design the next phase of research.

ORGANIZATION:

U.S. Dept. of Energy
Division of Biomedical & Environmental Research
1717 H. St. N.W.
Washington, District of Columbia 20545

TITLE:

Physical transport in water of Organics from Coal Conversion

PRINCIPAL INVESTIGATOR:

S.E. Herbes
U.S. Dept. of Energy
Environmental Sciences Division
P. O. Box E
Oak Ridge, Tennessee 37831

SUMMARY:

The objective is to relate structure (molecular size and functional class) of trace organics to their rates and extents of transport and transformation in natural waters. From laboratory data, compounds of concern will be identified for examination in microcosm and field studies. Processes examined include volatilization, photolysis/hydrolysis, and sorptive partitioning. Polycyclic aromatic hydrocarbons (PAH), a sequence of fused-ring compounds which are anticipated at trace levels in coal conversion wastewater streams, were examined. Sequences of 8 to 10 PAH are being tested to determine volatilization and hydrolysis/photolysis rates, and extent of sorption onto organic particles. Compounds are detected either fluorimetrically or by ^{14}C-labelling. Henry's Law constants are determined by measuring PAH loss from samples during nitrogen stripping with known gas volumes. Sorption studies use inoculation of ^{14}C-labelled PAH into 50 ml wastewater samples, centrifugal separation of particulate material, and quantification of ^{14}C in each phase. Photolysis/hydrolysis studies will be initiated in March 77 and will utilize presence and absence of ambient sunlight as experimental variables. Degradation products will be isolated by thin-layer chromatography and quantified.

RESULTS: Volatilization rates of PAH decrease from naphthalene to benz(a)anthracene. Sorptive partitioning onto wastewater particles at 25 degrees C increases from less than 1% for napthalene to 20-30% for benz(a)anthracene and benz(a)pyrene. Sorption onto autoclaved yeast cells follows thermodynamic predictions and fits a Langmuir isotherm. Both sorptive and evaporative processes appear to favor maintenance of larger PAH (4- and 5-rings or more) in aquatic systems.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Pollutants from Synthetic Fuels Processes

PRINCIPAL INVESTIGATOR:

F.O. Mixon
Research Triangle Institute
P.O. Box 12194
Durham, North Carolina 27709

SUMMARY:

Recognizing the importance of synthetic fuels in the nation's energy future, the Research Triangle Institute is conducting for the Environmental Protection Agency a major research program to study potential pollutants from synthetic fuels operations.

The purpose of the research is to develop a fundamental understanding of those factors and conditions which cause the production of environmental pollutants in synfuels processes and to provide to EPA and to the scientific and technical community the information needed to guide and control of potentially hazardous materials from synfuels plants of the future.

The research includes both an experimental and an analytical study. The experimental study includes first the design, fabrication and operation of one or more laboratory reactors to simulate conditions which may be utilized in action synfuels plants, second, the development and implementation of chemical analysis procedures for the evaluation of elements and compounds that result from synfuel reactors, third, the screening of the major coals which are available in the U.S. and characterization of compounds as dependent upon reactor parameters and input coal, and fourth, the determination of the kinetics of formation of the pollutants of significance.

The analytical study provides for utilizing results of the screening tests to project potential human exposure to effluents and emissions from these plants and to establish priority ratings for the various pollutants based upon the extent to which projected exposures are hazardous. The analytical study also provides for an understanding of the reaction kinetics with the view of producing the controls necessary for synfuels plants.

ORGANIZATION:

U.S. Energy Research and Development Admin.
Div. of Biomedical and Environmental Research

TITLE:

In-Situ Coal Gasification Pollutant and Effluent Characterization

PRINCIPAL INVESTIGATOR:

Dr. M.R. Peterson

SUMMARY:

The objective of this program is to conduct a characterization study which is useful in coal in situ gasification experiments which will identify any unforseen emission problems. The production of low BTU gas by in situ burning of coal has been demonstrated with considerable success by the Laramie Energy Research Center. In the studies at Hanna, Wyoming, a synthetic natural gas has been produced at 500-600 degrees F underground and has an energy content of approximately 150 BTU's per SCF. Representative samples of the particulates, gases, tars and condensate will be collected and analyzed for inorganic and organic constituents which are not normally monitored.

Neutron activation and X-ray fluorescence permits analysis for Cu, Zn, Ni, Ti, Cr, Mn, Ce, Br, Sb, Se, Hg, Cd, Fe, Sc, and As. Sampling forms of selective absorption traps are used for As and Hg speciation and for volatile organic compounds. Plasma arc emission-spectrometry, UV absorption spectroscopy, gas chromatography/mass spectrometry, and high pressure liquid chromatography and are used to analyze the various inorganic, organometallic and organic species absorbed on the traps.

ORGANIZATION:

U.S. Dept. of Energy
Assistant Administrator for Fossil Energy
1717 H St. N.W.
Washington, District of Columbia 20545

TITLE:

Hazardous and Other Undesirable Elements and Compounds in Supplementary Gaseous and Liquid Fuels from Coal

PRINCIPAL INVESTIGATOR:

A.G. Sharkey
U.S. Dept. of Energy
Pittsburgh Energy Res. Center
4800 Forbes Avenue
Pittsburgh, Pennsylvania 15213

SUMMARY:

Products from coal gasification and liquefaction including gas, oil, tar, water, and char will be investigated for toxic or hazardous components. Analytical techniques will be developed for determining organic and inorganic constitutents. Trace elements that possibly are toxic in the vapor form or produce hazardous compounds will be investigated by spark-source mass spectrometry, neutron activation, atomic absorption, and other techniques. Organic material associated with these streams will be analyzed by high-resolution mass spectrometry, combined gas chromatography-mass spectrometry, and other appropriate spectral techniques. Organic and inorganic contaminants also will be evaluated in terms of standard lists of hazardous compounds such as Threshold Limit Values (American Conference of Government Industrial Hygienists, U.S. Coast Guard List), lists prepared by the National Research Council, the Toxic Substance List published by HEW in 1971, and recent lists of carcinogens released by OSHA. (FE-TIMS).

ORGANIZATION:

U.S. Department of Commerce
National Bureau of Standards
Washington, District of Columbia 20234

TITLE:

Environmental Mass Spectrometry

PRINCIPAL INVESTIGATOR:

L.W. Sieck
U.S. Deptartment of Commerce
National Bureau of Standards
Washington, District of Columbia 20234

SUMMARY:

Project Objective: To conceive, develop and exploit novel tech. pertinent to EPA, NOAA, DOT, and NASA atmos. and water poll. meas. and modelling prog. To develop new methods for rapid analysis of fossil fuels and coat gasification products.

Project Approach: The modified NBS high pressure photoionization mass spec. will be used as detection system to test a new in-house developed concept for analysis of high molecular weight hydrocarbons and their derivatives occurring in fossil fuels. The specific method involves highly selective ion chem. and the utilization of the solvent for the fuel sample as the ionization source.

Prior Year Accomplishments: Alkyl iodide study completed, and data published. Submit discriminatory gasoline fingerprinting method developed and finalized.

ORGANIZATION:

U.S. Environmental Protection Agency
Office of Research and Development
Industrial Environmental Research Laboratory
Research Triangle Park, North Carolina 27711

TITLE:

Assessment and Control of Wastewater Contaminants Originating from the Production of Synthetic Fuels from Coal

PRINCIPAL INVESTIGATOR:

Prof P.C. Singer
University of North Carolina
School of Engineering
Chapel Hill, North Carolina 27514

SUMMARY:

This is one of a multi-part project whose summary may be identical to others.

The purpose of this project is to assess the environmental impact of wastewater contaminants originating from the production of synthetic fuels from coal, and to evaluate alternative wastewater treatment technologies for the control of these contaminants. The project is carried out in several phases over a 5-year period consisting of (a) a literature review and survey of pilot- and full-scale coal conversion facilities to identify specific contaminants which might be found in coal processing wastewaters, (b) a study of the biodegradability of selected organic constitutents from such wastewaters including an assessment of the aquatic impact of these constitutents and biodegradation products, (c) biological and physical-chemical treatability studies of selected organic constituents and identification of the residuals following treatment, (d) animal toxicology studies to evaluate the potential health effects of those wastewater components for which sufficient information is not available in the literature, (e) treatability studies of composite synthetic and real coal-processing waters including analytical characterization and aquatic impact assessment of the treated waters, and (f) development of design criteria treatment of wastewaters from coal-conversion facilities.

ADDENDA:
1. The supporting organization's Project Monitor is TW Petric
2. Project's Starting Date: 11/76
3. Estimated Completion Date: 10/81

ORGANIZATION:

U.S. Dept. of Energy
Division of Biomedical and Environmental Research
1717 H St. N.W.
Washington, District of Columbia 20545

TITLE:

A Comparative Study of Effluents and their Control from Four Dry Ash Lurgi Gasification Plants

PRINCIPAL INVESTIGATOR:

Dr. M.H. Somerville
University of North Dakota
School of Engineering
Grand Forks, North Dakota 58201

SUMMARY:

This project is to identify and categorize the effluents from and control methods utilized in the following coal gasification facilities; 1) Transwestern Coal Gasification Company, 2) El Paso Natural Gas Company, 3) ANG Coal Gasification Company and 4) Natural Gas Pipeline Company of America. Each plant will be evaluated with respect of existing and probable environmental regulations and the best available technology. The design reliability of projected effluent levels is estimated. This will be accomplished through a review of the design bases and where possible, review of operational data. The primary data base will be the filings with the federal government and the Environmental Impact Statements of the proposed facilities. The product of this effort will be a report delieating: 1) environmental control options and effluents anticipated from each of the gasification systems considered, 2) costs of the control options in terms of monetary and energy units, 3) environmental control design reliability and associated design on uncertainties, and 4) existing as well as probable environmental regulations not currently in existence. The above criteria will be evaluated and the contractor will recommend an RD&D program designed to develop environmental control methods where existing controls are inadequate.

RESULTS: The review of the four gasification plant facilities has been completed. This review has resulted in a complete summary of the gaseous liquid and solid effluents from all four facilities. Sulfur control techniques have been examined and some of the design weaknesses in the sulfur control techniques noted. A review of the proposed EPA gasification effluent limits and energy units are to be investigated during the coming quarter. The contractor has recommended additions to the ERDA RD&D program, particularly in the sulfur control area.

Coal Gasification Plants

ORGANIZATION:

U.S. Dept. of Energy
Assistant Administrator for Fossil Energy
11717 H St. N.W.
Washington, District of Columbia 20545

TITLE:

Coal Gasification Environmental Problems from Trace Materials in By-Products

PRINCIPAL INVESTIGATOR:

W. Vanmeter
University of Montana
School of Arts and Sciences
770 Eddy St.
Missoula, Montana 59801

SUMMARY:

This study consists of three tasks: (1) Obtain representative ash and other waste samples from several operating gasification pilot plants. (2) Leach the samples with distilled and natural ground water, an ammonium acetate solution, and sulfuric acid. The ammonium acetate (an ionic, buffered medium) will cause the release of many ions not removed by simple solubility in water, yet it will not mask the subsequent analysis of the toxic species. The sulfuric acid will indicate the amounts of metals that may be released over a long time. (3) Perform a qualitative and quantitative chemical elemental analysis on the leachates obtained in Task II to determine whether or not ground and surface water contamination may result from the interaction of natural forces with the fly ash, slag, and other by-products of coal gasification plants.

ORGANIZATION:

U.S. Energy Research & Development Administration

TITLE:

Environmental Effects from Leaching of Coal Conversion By-Products

INVESTIGATORS:

W.P. Vanmeter
University of Montana
School of Arts & Sciences

SUMMARY:

A typical full scale gasification plant producing 250 million SCF per day of fuel gas will generate about 400,000 tons of slag or ash per year. Virtually all of the trace mineral content of the coal will remain in this solid waste, and will probably be in a more easily soluble state than in the coal. This project will examine solid waste materials obtained from existing pilot plants to determine the characteristics of the material as concerns leaching of toxic or objectionable elements from it by the action of preconcentration moisture or groundwater. Eluants used will include distilled water, actual eastern Montana groundwater, 1 M ammonium acetate, and 0.01 Normal sulfuric acid. Elements determined will include, at least, Ba, Cd, Hg, Ni, Pb, Se, Mn, Sr and F. Data will be gathered in a way that will show the quantity released versus time (and volume) of elution. Computer processing of the data will allow estimation of the total amount of each element that would be released by elution for very long times (volumes). Results of the work will provide a basis for rational decisions concerning the nature of the ultimate disposal of the waste materials.

ORGANIZATION:

U.S. Energy Research and Development Admin.
Assistant Administrator for Fossil Energy

TITLE:

The Characterisitics of American Coals in Relation to Their Conversion into Clean Energy Fuels

PRINCIPAL INVESTIGATOR:

Penn. State University, University Park, Pensylvania 16802

SUMMARY:

In the research program dealing with investigations of cokes and chars, 1) studies of char reactivity as a function of coal rank are being conducted in air, steam, hydrogen, and carbon dioxide atmospheres; 2) enhancement of char gasification by mineral matter addition and ion-exchange to yield well-dispersed calcium is being attempted; 3) effects of heating rate, atmosphere, maximum temperature, and soak time variations during the conversion of coals to chars on subsequent char reactivity are being studied; and 4) small angle X-ray scattering, unsteady-state gas diffusion and DSC measurements on oxygen chemisorption techniques are being developed in order to better characterize chars.

The work performed this year concerning the combustion of low-volatile coals and chars has emphasized the development of a radiation model to provide insight into the reason for the different behaviors of gas temperature profiles obtained with the different samples.

Since the start of the new program a milestone has been reached in the successful burning of coal-oil-water-air emulsions.

CURRENT PROJECTS:
OIL SHALE OPERATIONS

ORGANIZATION:

U.S. Dept. of the Interior
Office of Water Research and Technology

TITLE:

An evaluation of the Effects of Geothermal Energy Development on Aquatic biota in the Geysers Area of California

PRINCIPAL INVESTIGATOR:

V.H. Resh

SUMMARY:

This study has been designed to evaluate the effects of the development and operation of geothermal energy power plants on the community organization and the energy transfer processes of aquatic benthic organisms in streams of the known Geothermal Resource Area (KGRA) Geysers, California. As selected stations, instantaneous growth rates, production and turnover ratios will be estimated for dominant benthic species and the entire benthic community. Physical parameters such as sedimentation rates and chemical measurements including ammonia, boron, arsenic, and mercury concentrations will be incorporated into a data matrix arrangement to develop a predictive model of the interactions occurring these environments. Study sites will include: 1) streams that have received sediment and other material from geothermal power plant construction and operating procedures; 2) streams that are adjacent to natural fumarole areas and received heated effluents prior to geothermal development; 3) streams that have received effluents from cinnabar mining operations; 4) streams that have received both geothermal and cinnabar effluents; 5) streams that have received no effluents. The results of this study will develop methods of using biological indicator organisms, particularly in analyzing any cumulative effects of the geothermal energy plants on aquatic biota.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Monitoring Guides for H_2S and Non-Condensible Hazardous Gaseous Emissions/ Geothermal Systems

PRINCIPAL INVESTIGATOR:

W. Adams
U.S. Environmental Protection Agency
Environmental Monitoring & Support Laboratory
P. O. Box 15027
Las Vegas, Nevada 89114

Objective: To develop a strategy for air quality monitoring as part of an integrated geothermal monitoring methodology for evaluating the total impact of geothermal development on a given locality.

Approach: The design of a monitoring network is accomplished in two phases. Field measurements of ambient air quality will be made and air quality simulations will be made for predicting temporal and spatial distributions of pollutants for various stages of geothermal development. Because meteorological and air quality data for this area are sparse, a two year field program is necessary to document aerometric data. A first year effort would be a pilot study for collecting meteorological data at several sites. Limited air quality data will also be collected during the first year. Data from the first year will be used as a guide to determine the level of effort for an expanded network in the second year. These data will be used as a basis for the air quality simulation phase of the project.

Outputs: Completion of initial investigation with air monitoring laboratory at 5 sites in the Imperial Valley, California (10/76); completion of second round of air monitoring at 4 sites in the Imperial Valley, California (4/77); initiate collection of continuous meteorological and air quality data at fixed sites near Roosevelt Hot Springs, Utah (10/77); completion of final round of air monitoring at 4 sites in the Imperial Valley (4/78); report on air monitoring strategy around geothermal sites (12/79).

ORGANIZATION:

U.S. Energy Research & Development Administration
Division of Biomedical & Environmental Research

TITLE:

Chemical Physics of Atmospheric Pollutants

PRINCIPAL INVESTIGATOR:

P.M. Dehemer
Argonne National Laboratory
9700 S. Cass Avenue
Argonne, Illinois 60439

SUMMARY:

Many non-nuclear technologies such as the use of coal for power generation and of geothermal sources are accompanied by the production [illegible] an enormous variety of gaseous pollutants which may enter into the chemistry of the lower atmosphere through photochemical and natural-molecular reactions. The chemical reactivity, as well as the toxicity, of these pollutants depends greatly on their specific molecular forms. Thus, in order to effectively assess the long-range environmental effects of coal use and other technologies, it is necessary to detect, characterize, and elucidate the reactions of each molecular species of the pollutants. The present program is directed toward determining through laboratory studies the chemical reactions and the physical properties of atmospheric pollutants. In particular, we will concentrate on classes of species whose physical and chemical properties are so similar as to prohibit routine detection of individual species with present air-pollution monitoring devices. These classes include sulfur and nitrogen containing compounds, hydrocarbons, aromatic organics, trace metals and their oxides, halogen containing compounds, and certain free-radical intermediates. Knowledge of which species within these classes may exist in the polluted atmosphere and their reactions is vital for a complete understanding of atmospheric chemistry.

Results: An apparatus for the study of free radical and other atmospheric reactions has been designed and is now under construction. Preliminary experiments determining the techniques for efficient production of atomic oxygen and excited molecular oxygen (al delta g) were performed on an existing appartus. Measurements of the photoelectron spectra and the angular distributions of the ejected photoelectrons are now being performed on the appartus.

Geothermal Energy Production

ORGANIZATION:

U.S. Energy Res. & Dev. Admin.
Biomedical & Env. Res. Div.

TITLE:

Geothermal Technology Environmental Impact Assessment

PRINCIPAL INVESTIGATOR:

J. Harte
University of California
Lawrence Berkeley Laboratory
Berkeley, California 94720

SUMMARY:

The program described here will focus on the environmental impact of LBL's geothermal project in Nevada. However, the general methodologies developed in this program will be applicable to many geothermal plants. The LBL program will consist of: (1) Detection and monitoring of radioactive and non-radioactive pollutants of air, land, and water (in some cases plants and animals) in both the immediate and surrounding areas of the geothermal production activity at the Buffalo Valley pilot plant. (2) Studies of the effects of geothermal technology on water resources. (3) Studies of the effect of geothermal technology on ecosystem stability and health (i.e., will plant, animal, and human life be significantly altered in areas surrounding geothermal energy production). In addition, the possibility of induced earthquakes, permanent land denudation, decreased aesthetic values, meteorological effects on gaseous dispersal, and noise effects will be considered in these environmental studies. Gaseous and fluid environmental pollutants will be measured using x-ray fluorescence, neutron activation, sodium iodide crystal gamma detection, Zeeman spectroscopy, and other techniques.

ORGANIZATION:

U.S. Environmental Protection Agency
Office of Research and Development

TITLE:

Geothermal Environmental Impact Assessment-Fauna

PRINCIPAL INVESTIGATOR:

W.W. Sutton
Z.C. Nelson
A.A. Mullen
G.D. Potter

SUMMARY:

Biological samples are collected at geothermal sites and analyzed for selected elements. The objectives will be to 1) provide baseline information prior to full scale energy production and 2) to examine the feasibility of using animals as biological monitors for geothermal pollutants. Rodents, rabbits, chickens and beef cattle represent various aspects of the field sampling program. The relative abundance/density of various wildlife species is also being investigated.

Approach: Field collected samples are transported back to Las Vegas and will be analyzed for such elements as lead, arsenic, zinc, and cadmium. Concurrent laboratory studies are designed to confirm tissue retention characteristics (or complicating homeostatic factors) for geothermal elements following quantitated oral exposures. These laboratory experiments serve as an essential part of the quality assurance effort and the laboratory generated samples will be analyzed by those techniques used for the field collected tissues.

Outputs: Samples have been collected from Roosevelt Hot Springs, Utah and from Imperial Valley, California. Relative abundance work on small mamal populations at Roosevelt Hot Springs is also in progress. Analytical data on the field collections and associated laboratory studies, are not available but should be reported next year.

CURRENT PROJECTS:
POTENTIAL QUALITY CONTROL STANDARDS

ORGANIZATION:

U.S. Energy Research and Development Administration

TITLE:

Trace Elements in the Environmental and Disease

PRINCIPAL INVESTIGATOR:

H. Aceto
College of William and Mary
Undergraduate School
Newport News, Virginia 23606

SUMMARY:

The technique of proton-induced X-ray emission has been further developed at the Environmental Science Laboratory at the Virginia Associated Research Campus so that now it is possible to simultaneously detect and quantitate all metals with atomic number greater than 12 and with detection sensitivities in the range of 1.0-1 ppm on a dry weight basis for all elements with Z greater than 20. Current research projects and those planned for the near future include the following: (1) Baseline concentrations of V, Cr, Fe, Ni, Cu, Zn, Cd, Ba and Pb in the immediate environment of the Atlantic offshore gas and oil drilling sites; (2) Correlation between trace elements in human serum and cancerous tissue in a few select tumors and alternations in the serum levels before, during and after therapy.

Results: (1) In aircraft exhaust, heavy toxic elements such as Sn and Pb tend to concentrate in small size aerosols. (2) Periodic and even one-time exposures of humans to metals such as As and Bi appear to get "recorded" in the long hair strands.

ORGANIZATION:

U.S. Department of the Interior

TITLE:

Combustion Derivatives of Fuel Additives

PRINCIPAL INVESTIGATOR:

U.R. Allsup
U.S. Department of the Interior
Bureau of Mines
Bartlesville, OK 74003

SUMMARY:

Detergent dispersant type additives used both in engine or dynamometer stands and in vehicle road tests. Emissions are measured and compared with baseline data obtained using non-additive fuel. Particular emphasis is placed upon detection and measurement of exhaust components that are logically traceable to the additive either as pass-through material or as a combustion-derivative of the additive.

Potential Quality Control Standards

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Sampling and Analysis of Emissions form Coke Oven Doors

PRINCIPAL INVESTIGATOR:

R. Barrett
Battelle Memorial Institute
505 King Avenue
Columbus, Ohio 43201

SUMMARY:

Objective: Evaluate the performance of the coke oven door emission sampling system by executing a complete sampling program over two coking cycles on one oven. Perform detailed elemental, organic, and bioassay analyses on the samples thus obtained.

Approaches: All emissions are contained within an enclosure around the door. Purging this enclosure maintains the door at its natural conditions. Samples were taken throughout the cycle of the existing purge stream. The collected emission samples will be subjected to rigorous analysis utilizing various techniques such as GC/MS, high resolution MS and biological evaluations. These samples, as well as coal and coke samples, will also be subjected to spark source MS for element identification.

Outputs: The final result will be published in a public report. It will provide detailed information concerning the sampling equipment, procedures, and analyses.

Potential Quality Control Standards

ORGANIZATION:

U.S. Department of Commerce
National Bureau of Standards

TITLE:

Electron Spectroscopy for Gas Analysis

PRINCIPAL INVESTIGATOR:

R.J. Celotta
U.S. Department of Commerce
National Bureau of Standards
Washington, D.C. 20324

SUMMARY:

The technique of electron energy loss spectrometry is being developed and applied to the analysis of gas mixtures. This method is quite general, an important consideration as pollution standards and regulations become more complex, and it is an absolute technique, which can be utilized to verify the accuracy of SRM samples. The unique energy loss spectra of the constituent gases have been measured individually and fitted linearly to the energy loss spectrum of the gas mixture, producing the relative concentrations as the coefficients of the fit. We have investigated the detection limits of various hydrocarbons in oxygen during the past year and will concentrate on the SRM problem of the measurement of N_O in N_2 this year.

Objective: To develop electron energy loss spectrometry as a gas analysis technique and to determine its sensitivity and advantages for particular measurement problems.

Motivation: As our highly industrialized society limits its impact upon the environment with an increasing number of standards and regulations, a more sensitive, more accurate, and a more generally applicable class of instruments is required. Many techniques exist which are very sensitive to a particular contaminant, but detect nothing else. As pollution standards become more complex, an instrument which determines all of the constituent concentrations will be favored over those measuring only one. Even now, to develop cleaner engines, the autombile manufacturers require instruments which make relative concentration measurements of the 500 odd hydrocarbons exiting from the tail pipe, rather than one or two.

ORGANIZATION:

U.S. Energy Research and Development Administration Biomedical and Environmental Research Division

TITLE:

Chemical Physics of Atmospheric Pollutants

PRINCIPAL INVESTIGATOR:

P.M. Dehmer
Argonne National Laboratory
9700 S. Cass Avenue
Argonne, Illinois 60439

SUMMARY:

Expanding technology, particularly that associated with non-nuclear forms of energy production, is likely to increase the variety and amounts of process chemicals and other toxic materials released into the environment. Many of these will be introduced as vapors (i.e., hydrocarbons, etc.). It is also expected that noxious vapors will be liberated by biogeneration of natural gas and other fuels and by geothermal energy production. Many of these molecular species will undergo photochemical reactions either in the troposphere by absorption of visible and near ultraviolet light or in the stratosphere and above by absorption of more energetic ultraviolet radiation. At still higher altitudes some species may further encounter a spectrum of relatively low-energy photoelectrons from the ionosphere. The identification and quantification of specific neutral atomic and molecular species generated after energy absorption by these pollutants is a major area for future study.

Potential Quality Control Standards

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Lidar Measurement of Aerosols

PRINCIPAL INVESTIGATORS:

V.E. Derr
U.S. Department of Commerce
Environmental Research Laboratories
Boulder, Colorado 80302

SUMMARY:

Objective: Develop lidar techniques for measuring particulate pollutants from energy production and their transport and dispersion processes.

Current Year Plan: Construct, test and evaluate polarization-sensitive aerosol lidar and measure stack emission vs. natural aerosols by polarization lidar.

Potential Quality Control Standards

ORGANIZATION:

U.S. Environmental Protection Agency
Office of Energy Minerals and Industry

TITLE:

Energy Related Water Pollutant Analyses Instrumentation

PRINCIPAL INVESTIGATOR:

R. Durst

SUMMARY:

To improve the accuracy of water pollution analysis through the development of reference materials and analytical reference methodology.

To investigate sources of error in water pollution methodolgy, to evaluate methods for reliable water pollution monitoring, to improve existing methods or develop new methods as needed to provide reliable pollution measurements. To measure fundamental equilibrium constants needed to interpret water pollution data. To develop reference materials needed to eliminate analytical bias.

Completed development phase for a heavy-metal-in-water SRM.

Potential Quality Control Standards

ORGANIZATION:

U.S. Environmental Protection Agency
Office of Research and Development

TITLE:

Synthesis and/or Purification of High-Purity Aromatic Compounds (Chiefly PNA Hydrocarbons)

PRINCIPAL INVESTIGATOR:

Dr. E.J. Eisenbraun
Oklahoma St. University
School of Arts and Sciences
Agriculture Hall
Stillwater, Oklahoma 74075

SUMMARY:

Continuation of the synthesis and/or purification of high-purity (99.9% goal) polynuclear aromatic compounds, chiefly hydrocarbons for possible use as analytical standards, is proposed. These hydrocarbons are of the types found in the products of incomplete combustion (automobile exhaust gases, stack gases) and hence appear as environmental pollutants. The lost of PNA compounds includes the following: (1) Hydrocarbons completed: Anthanthrene, Benzo(k)fluoranthene, Pyrene, Benze(a)-anthracene, Benzo(a)pyrene, 1,3,5-Triphenylbenzene, Benzo(b) fluroranthene, Dodecahydrotriphenylene, Triphenylene. (2) Compounds under preparation: Acridine, Benz(e)pyrene, Perylene, Benzo(j)fluoranthene, Chrysene (recently added). (3) Compounds proposed as future work: Benz(a)acridine, 11H-benzo(b)fluorene, Coronene, Benz(c)acridine, Benzo(ghi)perylene, Dibenz(a,h), anthracene, Benzo(mno)fluoranthene, Benzo(c)phenanthrene (recently added), Indeno (1,2,3,cd)pryene (o-phenylenepyrene).

In general, known synthesis routes are used, but their improvement is sought through use of new reagents and techniques. High-pressure liquid chromatography and/or zone refining is included in the purification procedures. Modern analytical techniques (glc, lc, tlc, nmr, mass and other spectrometric techniques) are used for identifying compounds and establishing teh purity of the synthesis products.

Potential Quality Control Standards

ORGANIZATION:

U.S. Energy Research & Development Administration

TITLE:

Instrumentation and Methods for Characterization of Inorganic and Organic Pollutants Emitted by Energy Generation Sources

PRINCIPAL INVESTIGATOR:

V.A. Fassel
Iowa State University of Science & Technology
Ames Laboratory
University Station, Box 14A
Ames, Iowa 50010

SUMMARY:

This study supports two projects: (a) laser pumped luminescence and microwave resonance spectroscopy as a new and sensitive approach for the detection of organic pollutants, especially carcinogens; and (b) absolute mass calibration for the multielement quantitative analysis of atmospheric aerosols and particulates.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Sampling and Analysis of "Reduced" and "Oxidized" Species in Process Streams

PRINCIPAL INVESTIGATOR:

Dr. C.A. Flegal
Thompson Ramo Wooldridge Incorporated
1 Space Park
Rendondo Beach, CA 90278

SUMMARY:

Under this contract, TRW will conduct a continuing program for the evaluation, development, testing and field adaptation of measurement techniques for elemental analysis and inorganic compounds identification in process and effluent streams. The primary objective of this program is to provide the measurement methodologies required for environmental assessment and control technology development projects related to the stationary source, energy and industrial process programs of the EPA. TRW will be responsible for conducting both the basic development effort and the programs necessary to apply and evaluate the application of these and other sampling and analytical techniques on specific engineering studies. The five (5) major program work areas are: 1. Measurement Methods Evaluation and Development; 2. Methods Adaptation and Application Studies; 3. Measurement and Test Program Reviews; 4. Sampling and Analytical Support; 5. Preparation of Guidelines and Procedures.

Potential Quality Control Standards

ORGANIZATION:

U.S. Department of Agriculture
Cooperative State Research Service

TITLE:

Polycyclic Aromatic Hydorcarbons in the Environment

PRINCIPAL INVESTIGATOR:

J.M. Hardin

SUMMARY:

Determine the distribution and levels of polycyclic aromatic hydrocarbons in soil, water and plants in relation to point or diffuse sources or origin, e.g. from power plants, incinerators, oil refineries, and automobile or marine engine exhausts. Make recommendations for land or water use that will avoid health hazards due to elevated concentrations of carcinogenic or cocarcinogenic polynuclear aromatic hydrocarbons.

Samples of soils, water, and plant materials will be collected from areas where enrichment of polycyclic aromatic hydrocarbons might be expected, e.g. from fallout near incinerators or oil refineries, from automobile exhausts near highways and in metropolitan areas, or from marine engine exhausts near marinas, as well as from control areas where background levels can be established. The hydrocarbon mixtures will be extracted, separated by high-pressure liquid chromatography and/or gas chromatography, and assayed by fluorescence spectroscopy. Regions of enrichment of these hazardous chemicals will be identified. Recommendations for land and water use in these areas will be made which will minimize the health hazard for these compounds.

The methodology for the isolation of polycyclic aromatic hydrocarbons (PAHs) from soils and their analysis has been further improve: Air-dry soil samples are Soxhlet continuously extracted with purified benzene. The extracts are concentrated and filtered through Millipore teflon filters to remove suspended particulates; alkaline permanganate oxidation is used to convert the interfering organic matter to easily separated compounds; preparative thin-layer chromatography on silica gel using cyclohexane/carbon tetrachloride (19/1) separates the PAHs from more polar organics; PAHs are extracted with dichloromethane and concentrated to 1 ml for analysis by gas chromatography. The anlysis is qualitative and quantitative for PAHs with 4 through 6 condensed rings. PAH levels are closely related to the organic matter content of the soil. PAH levels decrease sharply with depth in the soil profile. Rural areas have lower PAH levels that urban areas. Correlation of human activity and PAH levels is not yet possible, because there is still insufficient data.

Potential Quality Control Standards

ORGANIZATION:

U.S. Environmental Protection Agency
Office of Research and Development

TITLE:

Establishment and Improve Neutron Activation Analysis Capability

PRINCIPAL INVESTIGATOR:

T.B. Hoover
U.S. Environmental Portection Agency
National Environmental Research Center
Corvallis, Oregon 97330

SUMMARY:

This project assesses the applicability of neutron activation analysis to environmental samples. Application will be largely to tissue and sediments that cannot be dissolved satisfactorily for analysis be spectrometric techniques. To date the technique has been shown to have broad potential for multi-element analysis (up to 40 simultaneously) in sediments. The analysis for one or two elements in large numbers of samples has been quite successful for mercury and arsenic. Elemental finger-printing by neutron activation will be evaluated for its utility in identifying oils. Initially, work will be concentrated on oil from actual spills, where the source is known, to develop a method for supplementing or confirming GC identification. Heavy oils, such as asphalts and lubricating oils, that are difficult to identify by GC will also be investigated.

Potential Quality Control Standards

ORGANIZATION:

U.S. Department of Commerce

TITLE:

Research In Environmental Analysis (Air Pollution)

PRINCIPAL INVESTIGATOR:

E.E. Hughes
U.S. Department of Commerce
National Bureau of Standards
Washington, D.C. 20324

SUMMARY:

Objective: To develop advanced methodology and techniques for primary standardization of air pollution measurements. To develop state-of-the-art methodology for measurement of constituents of the normal atmosphere.

Approach: Techniques will be developed or improved for preparation of primary gas standards, by gravimetric, volumetric, and nanometric procedures. Instrumental methods will be developed for intercomparison of primary standards with each other and with SRM's to establish certification levels of the latter. Methodology so developed will be adapted and utilized, as possible, to the measurement of normal constituents of the atmosphere, and to the analysis of research samples to a limited extent. The program must be flexible to respond to the changing needs and priorities of the EPA and industry.

Progress: Studies of the stability of vinyl chloride-air mixtures were completed and indicated feasibility of certification of such mixtures as SRM's. High concentration mixtures of SO_2-air were found to be sufficiently stable when stored in passivated aluminum cylinders for use as SRM's. A gas-phase titration technique, utilizing SRM NO-nitrogen mixtures as reagents, was developed for possible use in certifying the NBS ozone generator as an SRM. A monitor for measuring exposure of personnel to mercury vapor was developed, utilizing piezoelectric detection. Improved certification procedures were developed for comparison of NO-nitrogen mixtures with primary standards. A gravimetric technique was developed for measurement of the composition of organic solvent-air mixtures after absorption on activated charcoal. Periodic measurements have been made on the NBS primary gas standards for automobile emission measurement to confirm their long-term stability.

Potential Quality Control Standards

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Energy-Related Radiological Monitoring Quality Assurance

PRINCIPAL INVESTIGATOR:

A.N. Jarvis
U.S. Environmental Protection Agency
Environmental Monitoring & Support Laboratory
P. O. Box 15027
Las Vegas, Nevada 89114

SUMMARY:

Objective: The objective is to determine the potential radioactive pollutants for which quality control standards, SRM's and procedures will be needed as the result of expanded nuclear power, fossil-fuel extraction, and geothermal activities and to supply these standards, SRM's and procedures to interested laboratories.

Approach: A report, "Potential Radioactive Pollutants Resulting from Expanded Energy Programs," was prepared for the EPA through a contractual agreement. Based on the results of this report, standard reference materials and calibrated samples, required for the analysis of samples obtained by monitoring activities in the vicinity of nuclear facilities, fossil-fuel extraction and utilization activities, and geothermal sites, are being developed.

Outputs: Laboratory intercomparison studies have continued. Standards, including radium-228, have been made available to laboratories upon request. Several guidelines, including use of radiation standards and gamma measurements techniques, have been prepared.

ORGANIZATION:

U.S. National Science Foundation

TITLE:

Thin Film Pollution Detectors for Use in Gaseous and Water Environments

PRINCIPAL INVESTIGATOR:

L.L. Kazmerski
University of Maine
School of Technology
251 Aubert Hall
Orono, Main 04473

SUMMARY:

A study is to be made of solid state thin film pollution detectors for use in both gaseous and water environments. A thin film environmental detector using an ultra thin (10-100 Å) metal or semiconductor film as its sensing element will be designed to function primarily in three pollution control situations: (1) Moving Source Emission, particularly to monitor CO-NO_x automobile emission, (2) Stationary Source Emissions, especially SO_x, and (3) Water Pollution, emphasizing the analysis of dissolved oxygen levels important to municipal and industrial waste treatment. The proposed devices will provide necessary accuracy and versatility in a number of critical intermittent and continuous monitoring situations and promise to be far less expensive than available systems.

Potential Quality Control Standards

ORGANIZATION:

U.S. Energy Research and Development Administration
Division of Biomedical and Environmental Research

TITLE:

Isolation and Identification of Polycyclic Aromic Hydrocarbons and Determination of their possible toxicity

PRINCIPAL INVESTIGATOR:

Dr. S.R. Lipsky
W.J. McMurray
G. Alexander

SUMMARY:

To develop methods for the isolation and identification of polycyclic aromatic hydrocarbons found in complex mixtures and the bioassay system. Procedure: High-efficiency glass capillary gas chromatographic columns operating in conjunction with mass spectrometry will be utilized to separate and identify the individual components of complex mixtures of polycyclic hydrocarbons derived during a coal conversion process. The chromatographic effluent will be directly or indirectly led into a vehicle which exposes one or more bioassay systems to several individually resolved components - on a time basis - as they emerge from the chromatographic column. Attempts will be made to correlate chemical structure with biological function i.e., signs of mutagenicity as determined by the bioassay techniques.

Results: a) Glass capillary column gas chromatography analysis of samples derived from a coal conversion process has revealed well over 100 individual polycyclic aromatic hydrocarbons and related structures. b) A host mediated assay-using L4178Y/ASN Murine Leukemia-has been established to screen isolated "groups" of this class of comounds for mutagenic effects. Suitable vehicles for the appropriate "transport" of these substances to the bioassay system are being investigated. Dose response curves are being established.

ORGANIZATION:

U.S. Department of Commerce
National Bureau of Standards

TITLE:

Coulometric Measurement of Nitrogen Oxides

PRINCIAPL INVESTIGATOR:

G. Marinenko
U.S. Department of Commerce
National Bureau of Standards
Washington, D.C. 20324

SUMMARY:

An absolute method for measurement of the concentration of oxides of nitrogen will be developed, based on reduction of ammonia which is coulometrically titrated. The total oxides may be determined directly and individual oxides will require a pre-separation. Techniques for separation of the components of mixtures will be investigated.

Objective: The objective of this program is to develop accurate and precise methods for the determination of nitric oxide (NO), nitrogen dioxide, and their mixtures.

Motivation: The best technique presently available for measurement of the nitrogen oxide content of dilute binary gas mixtures such as the automotive emission SRM's requires comparison with gravimetrically prepared primary standards. The danger of deterioration after preparation makes an independent method of assay very desirable and the consequences of analytical bias caused by such a deterioration needs no elaboration. Oxides of nitrogen can be reduced to ammonia by reaction with hydrogen, and this can be titrated using the accurate coulometric techniques developed at NBS. This present project was initiated to investigate the feasibility of this approach.

Approach: Techniques for the efficient reduction of oxides of nitrogen to ammonia will be developed. A coulometric cell, especially designed to absorb the ammonia gas in a small volume will be constructed. Coulometeric procedures will be developed to titrate the absorbed gas and the accuracy and precision of the method will be evaluated. Techniques will be investigated to separate individual oxides of nitrogens in mixtures so that each species may be analyzed.

Progress: A system was developed for coulometric measurement of the total nitrogen oxide content of binary gas mixtures, after reduction to ammonia and its performance evaluated. For higher concentrations of NO (greater than 0.1%) the precision of the results is 0.6%. The precision decreases for lower concentrations and is about 3% at the 2 ppm level. Investigation of the method for separation of nitrogen oxides in mixtures was initiated.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Energy Related Remote and in Situ Sensing Instrument Development

PRINCIPAL INVESTIGATOR:

Dr. G.B. Northam
U.S. National Aeronautics & Space Administration
Atmospheric Environment & Science Division
Hampton, VA 23665

SUMMARY:

Objectives: To develop and apply advanced electro-optical techniques to the measurement and characterization of power-plant and other source efflents.

Approach: To meet the project objective the following tasks will be conducted: Task 1 - Raman Lidar. - Evaluate Raman Lidar for remote measurement of the concentration of SO_2 and NO at a power-plant stack exit. (See Progress). Task 2 - Plume Dispersion Studies. - Apply aerosol scattering lidar techniques to the study of plume dispersion under various atmospheric conditions, (See Progress). Task 3 - IR Dial. - Develop and apply the tunable IR differential absorption lidar (DIAL) technique to the remote measurement of molecular plume effluents. Task 4 - Laser Heterodyne Detector. - Evaluate the use of the laser heterodyne detector technique as a means to increase the sensitivity of long path continuous wave absorption measurements using diffuse reflectors. Task 5 - HCl Monitor. - Develop and deliver to EPA an improved in situ HCl chemiluminescent monitor. The monitor will be evaluated at concentrations as low as 5 ppb HCl in ambient and polluted air.

Progress: Task 1 involving evaluation of the Raman Lidar for remote measurement of SO_2 and NO at power-plant stack exit, has been completed. Taks 2 which is intended to apply aerosol scattering lidar techniques to the study of plume dispersion under various atmospheric conditions has been postponed due to the lack of funding at this time.

ORGANIZATION:

U.S. Environmental Protection Agency
Office of Research and Development

TITLE:

Identification of Components of Energy-Related Wastes and Effluents

PRINCIPAL INVESTIGATOR:

Dr. Edo Pellizzari
Research Triangle Institute
P.O. Box 12194
Durham, North Carolina 27709

SUMMARY:

The long-term objective of the proposed research is to identify substances in wastes and effluents from energy-related processes. Information developed from this program will assist researchers who are concerned with control technology and monitoring techniques and the health and ecological effects of such energy-related pollution. The proposed work is divided into three phases. Phase A consists of a state-of-the-art summary and work planning which constitutes contacting EPA personnel to determine which energy-related solid waste and aqueous effluents have been analyzed for the purpose of identifying and measuring pollutants and which current contracts and projects will provide further identification. It will also consist of judging the reliability of existing information and the probability of accumulation of adequate data from current contracts and projects using pre-selected criteria. This information will be collated and summarized in a report for EPA. The report will identify gaps in existing and probable future data on chemical elements and volatile organic compound in solid wastes and aqueous effluents from coal mines, oil refineries, oil-shale processors, coal-fired power plants, coal liquefaction and coal gasification plants. Phase B consists of selecting sampling sites based on the recommendations from the report prepared in Phase A. The specific aims of Phase C consist of: (a) development and setup of analytical protocol, (b) qualitative and quantitative analyses for elements and organics in aqueous and solid wastes from the selected energy-related processes, and (c) the interpretation and collation of data obtained.

ORGANIZATION:

U.S. Department of Agriculture

TITLE:

Biological Indicators of Environmental Quality in California Lakes and Streams

PRINCIPAL INVESTIGATOR:

V.H. Resh
University of California
Agriculture Experiment Station
Berkeley, California 94720

SUMMARY:

Objective: Develop the concept of biological indicators of environmental quality as applied to California's lake and stream environments. Analyze the effect of potential impacting activities (e.g. geothermal energy development, organic and heavy metal effluents) on the energy transfer processes in aquatic ecosystems.

Approach: Streams and lakes throughout California will be selected for study. A statistically-sound sampling regime will be developed for quantitative biotic collections and measurements of key water chemistry and physical parameters. Diversity indices, production estimates, and bioassay procedures will be applied in which biological information, water chemistry measurements, and physical parameters can be used in preparing predictive models of the dynamic interactions occurring in these environments.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Identification of Components of Energy Related Wastes and Effluents

PRINCIPAL INVESTIGATORS:

Dr. J.F. Ryan
Gulf South Research Institute
P.O. Box 26518
New Orleans, LA 70186

SUMMARY:

Objectives: To determine the components of energy related wastes and effluents, both organic and inorganic.

Approach: (a) Organic - volatile components will be determined using a sparging technique whereby chemicals are concentrated on a polymeric resin, and then thermally desorbed into a CC/MS instrument for analysis. Semi-volatile components will be concentrated by solvent extraction at neutral, acid and base pH values. (b) Inorganic - all trace inorganic materials will be determined by spark source mass spectrometry except for mercury. The latter will be determined by flameless atomic absorption.

Current Plans: Selection of sampling sites and a review of all on-going research efforts in this area are first priorities. Sample collection and subsequent analysis will follow.

Potential Quality Control Standards

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Combustion Research on Coal Nitrogen and Particulate Organic Matter

PRINCIPAL INVESTIGATOR:

A.F. Sarofim
Massachusetts Institute of Technology
School of Engineering
77 Massachusetts Avenue
Cambridge, Massachusetts 02139

SUMMARY:

Task I. Characterization of POM from Diffusion and Premixed Flames. The research is concerned with the qualitative and quantitative assessment of the production of particulate organic matter in laboratory flames. The objectives are to determine within the flame and in the exhaust gases (1) the size distribution and concentrations of soot particles, (2) the identities and concentrations of organic compounds, (3) the relationship between soot and organic compounds generated in the flame. Experimental methodology used includes particle concentration and size distribution by electron microscopy, and analysis of polycyclic aromatic hydrocarbon by gas chromatographic mass spectormetry and high resolution mass spectrometry. The major emphasis involves the application of molecular beam sampler and on-line mass spectrometry for complete gas phase analysis. Additional information is obtained by sampling atmospheric pressure turbulent diffusion flames and laminar premixed flames by water-injected sampling probes.

Task II. Kinetics of Devolatilization of Nitrogen Compounds During the High Temperature Pyrolysis of Coal. The program objectives are to obtain a better understanding of the processes contributing to the emission of NOx from coal fired boilers to better define control methods. Fuel bound nitrogen complicates development of low NOx burners because the nitrogen in char may persist into the second stage of a staged combustor. During the past two years laboratory furnaces have been developed for the pyrolysis and oxidation of pulverized coal under conditions simulating utility boilers. Results on nitrogen retention in char have been determined for two coals as a function of temperature and time. Also, the conversion of the fuel nitrogen to NOx has been determined as a function of fuel/air ratio for one furnace temperature. Five additional coals will be studied over a wider range of temperatures and data will be obtained on the gas phase constituents of pyrolysis. The coals chars will be characterized to develop mechanistic models for extrapolation of data to other conditions.

Potential Quality Control Standards

ORGANIZATION:

U.S. Energy Research and Development Administration
Division of Biomedical and Environmental Research

TITLE:

Relative Toxicity of Individual Organic Components of product Waters from Energy Conversion Processes

PRINCIPAL INVESTIGATOR:

T.W. Schulz
J.N. Dumont

SUMMARY:

From ongoing work we have observed that the untreated product waters from energy conversion processes are highly toxic. Using the model system Tetrahymena pyriformis we are investigating the relative toxicity of oil shale retort water. We have examined the behavior and respiratory effect of the major organic components of these waters and are currently examining the cytological alterations with population growth studies to follow. Attempts will be made to correlate toxicity with physical-chemical constants such as partition coefficients and Hammett electronic constant.

RESULTS: Examination of the relative toxicity of the major organic components of Synthane product water (phenol and substituted phenols). The cresols are the least toxic group while the dimethylphenols express the greatest variation with a group. The amount of carboxylic acids, the major organic components of shale oil retort water, required to cause a behavioral effect similar to that caused by 5% product water (100% lysis in 300 min.) is 2,500 plus or minus 250 mg/liter. This is more than 20 times the total carboxylic acid concentration in 5% toxicant. Even less toxic are the amides.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Development & Application of Multiple Tracer Techniques for the Study of Pollutant Transport and Dispersion in the Atmosphere

PRINCIPAL INVESTIGATOR:

Professor F.H. Shair
California Institute of Technology
School of Engineering
1201 E. California Boulevard
Pasadena, CA 91109

SUMMARY:

This is a proposal requesting support for the further development and application of multiple atmospheric tracer techniques.

The analytical approach is to extend the use of electron capture gas chromatography. Recently, with the helpful suggestions given to us by Ray Dixon, we have developed systems which separate SF_6, $CBrF_3$, CCl_2F_2, O_2, and CBr_2F_2 into sharp distinct peaks, the last of which elutes within 200 seconds from the time of injection. The rest of the system development is to develop the capability to accurately analyze at least 1000 air samples per day.

The first extended application of this multiple tracer technique would be to determine the transport and extent of dispersion associated with: (1) urban sources (emitted at low levels) and (2) rural power plant plumes emitted at high levels. Specific experiments are planned to accurately determine the extent of vertical dispersion associated with plumes traveling over rural regions and over urban-regions.

ORGANIZATION:

U.S. Environmental Protection Agency

TITLE:

Methods for Analysis of N- and S- Containing Compounds

PRINCIPAL INVESTIGATOR:

J.E. Sigsby
U.S. Environmental Protection Agency
National Environmental Research Center
P.O. Box 12055
Durham, North Carolina 27711

SUMMARY:

The exhaust of vehicles which burn heavy petroleum fractions as fuels may contain potentially hazardous compounds such as acridine and thiophene derivatives. An experimental program to evaluate N- and S- specific detectors for gas chromatography for the determination of such compounds in vehicle exhaust has been instituted. It is anticipated that such heavy organics will be sought in the exhaust of diesel and turbine power plants. Project initiated January, 1973, anticipated completion date December, 1974.

ORGANIZATION:

U.S. Environmental Protection Agency
Office of Research and Development

TITLE:

Energy Related Water Monitoring Data Integration

PRINCIPAL INVESTIGATOR:

R. Thomas
V.W. Lambou

SUMMARY:

Establish a water monitoring network throughout the western states to monitor and assess the impact of energy resource development.

Through the use of computer data banks, primarily STORET, water monitoring stations that have been in operation, since 1970, and have reported a large number of measured parameters were selected for incorporation into a primary monitoring net. Parameters of interest were indentified and a quality assurance program is being established in participating laboratories. Historical data have been reviewed and baseline water quality conditions are being established. A Western Energy Resources Atlas has been published in conjunction with a similar effort on air monitoring.

Data from the primary net stations is being augmented with data from other stations. An assessment of baseline water quality, trends, and on a basin by basin basis is underway. As data stations are identified, actions will be taken with appropriate EPA Regional Office or other governmental agencies to correct them. The primary net will be updated periodically and extended into areas not presently addressed.

Potential Quality Control Standards

ORGANIZATION:

Energy Research and Development Administration

TITLE:

Polynuclear Aromatic Hydrocarbons in Coal-Identification by their X-Ray Excited Optical Luminescence

PRINCIPAL INVESTIGATOR:

C.S. Woo
Ames Laboratory-ERDA and
Department of Chemistry
Iowa State University
Ames, Iowa 50011

SUMMARY:

Several polynuclear aromatic hydrocarbons have been isolated from raw coal and detected by their characteristic X-ray excited optical luminescence spectra.

Potential Quality Control Standards

ORGANIZATION:

U.S. Department of Defense

TITLE:

Evaluation of Energy - Dispersive X-ray Fluorescence Analysis for Use in the Environmental Protection DB Program

PRINCIPAL INVESTIGATOR"

S. Yamamoto
U.S. Navy
Biosystems Research Department
San Diego, CA 92132

SUMMARY:

This program proposes to evaluate the utility of energy-dispersive x-ray fluorescence analysis in the assay of EPDB samples. If the method is found applicable to the EPDB program, a substantial cost savings will be effected in the analysis of trace metals because of the rapidity with which determination can be made.

(1) Evaluate existing energy-dispersive X-ray fluorescence analysis systems for the determination of trace metals in typical EPDB samples of air filters (including samplings of stack and aircraft emissions), water, and sediments. (2) Improve sensitivity of the method by optimization of instrument parameters and sample preparation methods. (3) Develop procedures for routine analysis of samples and compile a data base of X-ray fluorescence analysis of NEPDB samples. (4) Study the applicability of the method for field monitoring by testing in NUC van. (The analyzer system is already mounted in a van.)

Potential Quality Control Standards

ORGANIZATION:

U.S. Department of the Interior
Office of Water Res. & Tech.

TITLE:

Remote Detection of Water Pollutants by Computerized Laser-Raman Spectroscopy.

PRINCIPAL INVESTIGATOR:

University of Rhode Island
School of Arts
Administration Bldg.
Wakefield, Rhode Island 02881

SUMMARY:

In the proposed research the technique for detecting solutes remotely by Raman spectroscopy will be applied to real polluted samples and the detectivity of the method will be increased. These goals will be accomplished by computerizing the Raman spectral data, so that background signals due to fluorescence and Rayleigh scattering can be eliminated, and so that time averaging can be applied to increase the detectivity. The method will be tested on laboratory samples, field samples, and oil films. Furthermore, computer methods will be developed to automatically identify and determine the concentration of pollutants in field samples.

ORGANIZATION:

U.S. Energy Res. & Dev. Admin.
Biomedical & Env. Div.

TITLE:

Physical Methods and Instrumentation for Monitoring Contaminants

PRINCIPAL INVESTIGATOR:

Unknown
Univ. of California
Lawrence Berkeley Laobratory
Berkeley, California 94720

SUMMARY:

This project covers a broad range of studies of physical methods and instrumentation applied to environmental monitoring. The production and dispersal of potentially harmful chemical species by present and future energy sources demand adequate instrumentation to monitor these contaminants. Studies of their dispersal and uptake in biological species, and of their effects, depend upon reliable measurements of chemical elements and compounds present at very low concentrations. The use of physical methods, as opposed to conventional chemical analysis techniques, appears to be essential in view of the potential scale of the monitoring problem. Promising methods include infrared absorption and emission spectroscopy, x-ray fluorescence, neutron activation and charged particle scattering to study elemental composition; and, finally photoelectron spectroscopy to study the chemical states of elements. Development of these techniques, and the design and engineering of large-scale monitoring systems based upon them, has proceeded rather slowly and in an uncoordinated manner due to the diversity of interest groups involved in their development. The present project is designed to focus the attention of an experienced research, development and engineering group onto the application of these methods to deal with the anticipated large-scale monitoring problems.

Potential Quality Control Standards

ORGANIZATION:

Ledoux & Company

TITLE:

Research Into Analytical Procedures Covering Energy Related Fields

PRINCIPAL INVESTIGATOR:

Ledoux & Company
Teaneck, New Jersey 07666

SUMMARY:

Ledoux Co. is engaged in activities relating to the energy field by nature of the necessity to establish analytical procedures in the fuel-enrichment and fuel reprocessing fields. For instance Ledoux and Co. staff continuously experiment with advanced analytical systems to improve mass spectrogeographic determinations of uranium isotopes to improve methods input and output in the reprocessing cycle. All projects are interwoven in as much as they are covered by the same personnel which also are engaged in developing better methods of analysis for plutonium and palladium in catalysts for automotive exhaust control, and also in methods to improve the technology of analyzing performing catalysts.

Potential Quality Control Standards

TECHNICAL REPORTS:
COAL STRIP MINING

TITLE:

A Western Regional Energy Development Study: Primary Environmental Impact. Volume I.

AUTHOR:

Radian Corporation

ADDRESS:

Radian Corporation
8500 Shoal Creek Boulevard
Box 9948
Austin, Texas 78766

REFERENCE:

PB 246 264 NITS

ABSTRACT:

Arizona, Colorado, Montana, New Mexico, North Dakota, Utah, and Wyoming contain coal, oil, natural gas, oil shale, tight gas sands, tar sands, uranium, and geothermal resources. Radian examines the primary environmental impacts of 38 energy resource development scenarios: the air and water emissions, solid waste, and land requirements of a plant or process. Projected ground level ambient concentrations of pollutants are compared with federal and state standards. Scenarios include all aspects of development: extraction, conversion, and transportation to the point of end use.

TITLE:

Stream Quality in Appalachia as Related to Coal-Mine Drainage, 1965

AUTHOR:

J.D. Biesecker and J.R. George

REFERENCE:

Geological Survey Circular 526

SUMMARY:

A stream-quality reconnaissance at 318 locations in May 1965 offered the first opportunity for a contemporaneous regional collection and appraisal of water-quality data in Appalachia. The results provide a means of regional conparison of the influence of coal-mine drainage on stream quality at approximately median streamflow. The results disclose that the chemical quality of the water at nearly 200 sites did not meet recommended drinking-water standards. At many of these sites, inferior quality was caused by excessive concentrations of solutes commonly associated with coal-mine waters.

Water-quality damage from mine drainage is particularly severe in the more heavily mined northern one-third of the region where high sulfate content, free mineral acidity, and low pH are typical of most affected streams. A deficiency in natural stream alkalinity in this part of the coal region contributes greatly to the massive effect of mine drainage upon stream quality. However, data collected from streams affected by mine drainage along the west edge of this part of the coal field suggest extensive neutralization of mine water. In southern Appalachia coal-mine drainage had less influence on stream quality than in northern Appalachia. Fewer streams in this area were influenced by mine drainage, and the magnitude of stream damage for affected streams was less than in northern Appalachia.

TITLE:

Coal and Coal Mine Drainage

AUTHOR:

J.T. Boyer and V.E. Gleason

ADDRESS:

Bituminous Coal Research, Inc.
Monroeville, PA

REFERENCE:

CA:85 (24) 181791

SUMMARY:

Standards regulating the quality of point source discharge from coal mines and coal preparation plants being promulgated by the U.S. EPA were discussed by Schaffer along with the requirements of the Federal Water Pollution Control Act; individual coal mining activities that require permits were itemized. Some discharges that may be considered nonpoint sources were described by Hill in a general review of mining and its related problems that emphasized acid mine drainage abatement and control of discharges from abandoned underground mines and surface mines.

TITLE:

The Circle West Project: A Demonstration of the Compatibility of Mining, Manufacturing and Agriculture

AUTHOR:

E.C. Bredeson, G.G. Dahl and D.S. Gleason

REFERENCE:

Lignite Symposium; May 18-19, 1977; Grand Forks, ND

SUMMARY:

The Circle West project is an undertaking of the Burlington Northern Company which will be a working example of the productivity of coal strip mining and its innate compatibility with the surrounding environment. In essence the project consists of the actual recovery of the sub-surface lignite and the adjacent construction of an ammonia-methanol production plant which will be totally independent of outside resources and will utilize the coal being mined for power production. This report describes the objectives of the project, tentative layout of the ammonia-methanol plant, and environmental impact on the area, with particular emphasis placed on pollution control systems and possibly beneficial by products, such as a final effluent rich in phosphates which could be used for irrigation in adjacent agricultrual areas.

Coal Strip Mining

TITLE:

Implications of the Water Pollution Control Act of 1972 for the Mineral Resource Industry, A Survey

AUTHOR:

Bureau of Mines Interdisciplinary Research Task Force Committee

ADDRESS:

U.S. Department of the Interior
Stanly K. Hathaway, Secretary
Jack W. Carlson, Assistant Secretary-Energy and Minerals
Thomas V. Falkie, Director-Bureau of Mines

REFERENCE:

Information Circular 8681

SUMMARY:

This report summarizes the cost of U.S. mining and milling industry compliance with the Environmental Protection Agency (EPA) interim water quality guidelines for waste discharges. Applicable excerpts from Public Law 92-500 are stated and interpreted in conjunction with the guidelines being used for implementation of the law.

Over 200 U.S. Army Corps of Engineers applications for discharge permits were used to develop the quality and quantity data base needed to estimate the cost to comply with EPA guidelines.

Cost of three basic treatment methods were considered: Aeration, addition of lime, and sedimentation. From the process design, cost-capacity graphs were developed to consider maximum flow rate, maximum lime addition, and average flow rates. The graphical method used in this evaluation should provide a reasonable guide to the effect of waste treatment and, therefore, Public Law 92-500 and corresponding EPA guidelines on the mineral processing industry.

The cost of complying with the EPA guidelines will have the effect of prompting the mining industry to minimize the production of waste water and of undertaking some additional treatment. Two case studies are presented to illustrate efforts that might be fruitful for minimizing waste water production and for treatment of combinations of acid mine drainage, mill wastes, and metallurgical process wastes when treatment is deemed necessary.

TITLE:

A Study of Coal-Associated Wastes Resulting from the Mining, Processing and Utilization of Coal

AUTHOR:

Jerry L. Coalgate

ADDRESS:

Coal Research
West Virginia University
Morgantown, W.VA. 26506

REFERENCE:

FE 1218-T-1 NTIS
UC 901

This bibliography provides a readily available review of information dealing with the utilization of wastes produced during the mining, preparation, combustion, gasification, and coking of coal. Such wastes could serve potentially as sources of fuels, building and construction materials, and of new materials for the metallurigical, chemical water treatment, and agricultural industries. Chapters are included concerned with: acid mine drainage, utilization of coal mining refuse, coal refining and preparation wastes, shale, coal, coal dust and fines, coal ashes and coal slags, chars, coke breeze and coking wastes, and coal gasification. The published literature covered by the bibliography was produced in the period between 1900 and 1972. References were compiled from several sources, including Chemical Abstracts, 1970-1972.

TITLE:

Probable Analytical Sensitivites Required for Trace-Element Studies of Mine Spoils

AUTHOR:

Jon J. Connor

ADDRESS:

U.S. Geological Survey, Denver, Co. 80225

SUMMARY:

A collection of standard reference materials for use in problems arising from environmental degradation due to coal extraction should include materials typical of the natural predevelopment landscape. A recently completed U.S. Geological Survey study of the geochemical nature of the landscape in Missouri has provided data on the expected concentration and expected range in concentration for a host of trace metals in the coal-bearing region of the state. Concentration ranges for five trace metals (Cd, Hg, As, Pb, Se) generally recognized as hazardous in a variety of landscape materials were determined. Most of these ranges were computed as the expected 95% range of the element distribution measured in randomly collected sample sites. The metals were analyzed by a variety of methods. The data suggested that standardized methods of analysis for work in mine spoils should have sensitivities in the parts-per-million level for arsenic and lead, the parts-per-billion level for cadmium, mercury, and selenium, and the nanograms-per-liter level in water.

TITLE:

Coal-Energy Development in the Northern Great Plains

AUTHOR:

Jack R. Davidson

ADDRESS:

Wyoming University, Laramie. Water Resources Research Institute.

REFERENCE:

PB-231 560/4 (NTIS)

SUMMARY:

The growth demand for clean energy has focused attention on western coals, particularly the extensive lignite and subbituminous deposits in the Northern Great Plains. The Fort Union Powder River Coal beds, which underlie a part of northern Wyoming, southeastern Montana and western North Dakota offer the greatest potential for development, because of the vast quantitites of coal which can be strip mined. The U.S. Government has undertaken to assess coal/energy development problems through the Northern Great Plains Resources Program (NGPRP). The Water Research Institutes of the three-state area, together with the Office of Water Resources Research, undertook the following tasks: to determine the study needs, to inventory current research efforts and to assess their potential contribution, to establish the priorities for study as seen by the decision makers in the three states, and to assess the capacity of the region's scientists to carry out the needed studies. Eight categories for study were identified: Trace elements; Atmospheric Effects: Surface Resources (including Reclamation); Coal Resources and Mining Techniques; Water (including Water Quality); Economic and Social Issues; Institutional and Legal Issues; and Technology Development.

TITLE:

Western Coal Deposits Pertinent Qualitative Evaluation Prior to Mining and Utilization

AUTHOR:

Albert F. Duzy, Martial P. Corriveau, Roy Byrom, and Raymond E. Zimmerman

ADDRESS:

Paul Wier Company, Chicago, IL

REFERENCE:

Paper presented at the 1977 Ninth Annual Lignite Symposium, May 18, 1977, Grand Forks, ND

SUMMARY:

This paper demonstrates how coal deposits in the Western U.S.A. are (or should be) evaluated, with the objective being focused on their efficient utilization. The discussion includes three main areas of coverage: namely, the acquisition and evaluation of data for utilization; methods of analyses for determination of quality; and coal beneficiation.

Coal Strip Mining

TITLE:

Western Coal Deposits - Pertinant Qualitative Evaluations Prior to Mining and Utilization

AUTHOR:

Albert F. Duzy, Martial P. Corriveau, Roy Byrom

ADDRESS:

Paul Wier Company
Chicago, Ill.

REFERENCE:

Technology and Use of Lignite Symposium
Grand Forks, N.D. May 1977 (GFERC/IC-77/1) page 13

SUMMARY:

Coal exploration programs for evaluation of Wester U.S. coal deposits are discussed. The included programs are: problems associated with evaluation for efficient utilization.

Coal Strip Mining

TITLE:

Demonstration Plants

ADDRESS:

Engineering and Economic Systems Analysis, Fluor, Utah

REFERENCE:

Shaping Coals Future through Technology, 1974-1975
Office of Coal Research, Washington, D.C. 20242
Stock # 024-014-0012-2

SUMMARY:

The objective of the Fluor Utah Study is to identify and define the physical, technical, social, economic, legal, and environmental problems associated with producing 75,000 or more tons of coal per day from individual U.S. surface mines. Costs, safety, continuity of supply, conservation of resources, and minimum environmental damage are the constraints under which the study is being conducted. In addition to information on problems involved in large-scale surface mining, the project will provide recommendations for further research and development appropriate to future, large-scale surface coal-mining systems.

Research in coal liquifaction and gasification processes established that commercial conversion plants will be very large, requiring substantial capital investment and access to very large reserves of coal (up to 75,000 tons per day or more from a single mining operation). These projected mining operations will be far larger than any coal-mining system currently in operation.

Since contract award, this project has become even more important as the shortfall between U.S. oil production and consumption continues to grow and as the need for oil importation exerts an unfavorable influence on the U.S. balance of payments. Adding further importance is the cartel power of the oil-exporting nations which has resulted in dramatic increases in the prices of crude oil and petroleum products.

Coal Strip Mining

TITLE:

Bibliography of Strip Mine Ecology

AUTHOR:

D.C. Glenn-Lewin; G. Fay; S.D. Cecil

ADDRESS:

Iowa State University of Science and Technology, Ames. Energy and Mineral Resources Research Institute, Energy Research and Development Administration

REFERENCE:

IS-ICP-20 (NTIS)

SUMMARY:

This bibliography is intended to serve those interested in the ecology, environment, and reclamation of surface-mine spoil banks, especially those of coal strip-mines. The list is hopefully as complete and up-to-date as possible, although there are undoubtdly several omissions. Placement of the titles into various categories is necessarily arbitrary in some cases. Papers which clearly overlap categories have been cross-listed in two or more places. Other bibliographies which are listed, have not been broken up by titles; that is the contents of other bibliographies may not be listed. (ERA citation 02:000069)

TITLE:

Environmental Protection in Surface Mining of Coal

AUTHOR:

Grim, Elmore C., Hill, Ronald D.

ADDRESS:

National Environmental Research Center, Cincinnati, Ohio

REFERENCE:

PB-238 538/3ST (NTIS)

SUMMARY:

Premining planning is emphasized and particular attention is given to incorporating mined-land reclamation into the mining method before disturbance. Strip and auger mining methods, as well as equipment, are described and evaluated. New mining methods that will maximize aesthetics and minimize erosion, landslides, deterioration of water quality are discussed. Blasting techniques and vibration damage controls are recommended. Methods of land reclamation including spoil segregation, placement, topsoiling, grading, burying of toxic materials, and revegetation are noted. Technology for the control of erosion and sediment in the mining area is presented. Costs are given for different degrees of reclamation and remedial measures for controlling pollution from surface mines. Water quality change is discussed in detail. Research needs are listed.

TITLE:

Energy Options to the Year 2000

AUTHOR:

Richard E. Balzhiser

ADDRESS:

Electric Power Research Institute, P.O. Box 10412, Palo Alto, CA 94303

REFERENCE:

Chemical Engineering, 84 (1), 73 (1977)

SUMMARY:

The article discusses the U.S. fuel and energy options for the next 25 years. It is the author's opinion that coal primarily, and nuclear power seem to be the most likely candidates, and that natural oil and gas (domestic or imported), geothermal, hydrothemal and solar energy will play important but comparatively minor roles.

TITLE:

Coal Creek Station Steam Generators

AUTHOR:

W.W. Hickok, D.A. Taylor, R.W. Kierstead

REFERENCE:

Technology and Use of Lignite Symposium
Grand Forks, N.D. May 1977 (GFERC/IC-77/1) page 43

SUMMARY:

Mining, handling, combustion systems, flue gas cleaning and waste disposal are reviewed.

TITLE:

Erosion and Sediment Control. Surface Mining in the Eastern U.S.
Volume I. Planning. Volume II. Design

AUTHOR:

Hittman Associates, Inc., Columbia, Maryland

ADDRESS:

Environmental Protection Agency, Cincinnati, Ohio, Office of Technology Transfer.

REFERENCE:

PB-261 343/8ST (NTIS)

SUMMARY:

This publication presents an evaluation of the effectiveness of sediment ponds in reducing suspended solids in the runoff from surface mining activities. Nine selected sedimentation ponds in the three eastern coal-mining States of Pennsylvania, West Virginia, and Kentucky were sampled under two different operating conditions, a baseline and rainfall event. Their theoretical and actual efficiencies of removal of suspended solids are computed and compared.

Coal Strip Mining

TITLE:

Environmental Impact of Coal Research and Development

UATHOR:

Hittman Associates, Inc.

ADDRESS:

9190 Red Branch Road, Columbia, Maryland 21045

SUMMARY:

The growth of coal based industries is dependent upon the advancement of coal technologies and other policies which may have an indirect impact on coal. To characterize probable growth and ultimate size of coal-based industries a clear understanding of possible futures could result from trends in energy comsumption through 2025 must be developed.

Coal Strip Mining

TITLE:

Potential Impact of the Development of Lignite Reserves on Water Resources of East Texas

AUTHOR:

Wesley P. James; Frank J. Slowey; Robert L. Garrett; Carlos Ortiz; Jon Ortiz

ADDRESS:

Texas A and M University, College Station. Water Resources Institute.
Office of Water Research and Technology, Washington, D.C.

REFERENCE:

PB-263 492/1ST (NTIS)

SUMMARY:

Potential adverse effects of lignite strip mining and lignite utilization on the hydrology and water quality of East Texas are identified. Studies included (1) monthly water sampling for all one-year period of streams, lakes and wells near the strip-mined areas and at control stations located away from the lignite development; (2) leaching studies of the lignite and overburden at Fairfield and Rockdale; (3) precipitation samples collected under the airborne waste plume from the lignite-fueled electric generating plant at Fairfield; and (4) a limited trace element enrichment study in the soils around the plant at Fairfield.

Coal Strip Mining

TITLE:

Effectiveness of Surface Mine Sedimentation Ponds

AUTHOR:

D. Vir Kathuriz, Michael A. Nawrocki, and Burton C. Becker

ADDRESS:

Hittman Associates, Incorporated
Columbia, MD 21045

REFERENCE:

EPA-600/2-76-117
August, 1976

SUMMARY:

An in-field evaluation of the effectiveness of sediment ponds in reducing suspended solids in the runoff from surface mining activities was performed. Nine selected sedimentation ponds in the three eastern coal-mining States of Pennsylvania, West Virginia, and Kentucky were sampled under two different operating conditions--a baseline and a rainfall event. Their theoretical and actual efficiency of removal of suspended solids were computed and compared.

In general, poor construction and inadequate maintenance of these ponds were found to be the major problem areas. The ponds had generally higher removal efficiencies during the baseline sampling period and much lower efficiencies during the storm event. The theoretically predicted efficiency of the ponds was essentially the same as the actual efficiency under baseline conditions. During the rainfall event, there was generally little or no correlation between the theoretical and actual efficiencies. The predited efficiencies were found to be much higher than the actual efficiencies druing the rainfall event in most cases.

Coal Strip Mining

TITLE:

Effectiveness of Surface Mine Sedimentation Ponds

AUTHOR:

D. Vir Kathuria; Michael A. Nawrocki; Burton C. Becker

ADDRESS:

Hittman Associates, Inc., Columbia, Maryland, Industrial Environmental
Research Laboratory, Cincinnati, Ohio.

REFERENCE:

PB-258 917/4ST (NTIS)

SUMMARY:

An in-field evaluation of the effectiveness of sediment ponds in reducing suspended solids in the runoff from surface mining activities was performed. Nine selected sedimentation ponds in the three eastern coal-mining States of Pennsylvania, West Virginia, and Kentucky were sampled under two different operating conditions--a baseline and a rainfall event. Their theoretical and actual efficiency of removal of suspended solids were computed and compared. In general, poor construction and inadequate maintenance of these ponds were found to be the major problem areas. The ponds had generally higher removal efficiencies during the baseline sampling period and much lower efficiencies during the storm event. The theoretically predicted efficiency of the ponds was essentially the same as the actual efficiency under baseline conditions. During the rainfall event, there was generally little or no correlation between the theoretical and actual efficiencies. The predicted efficiencies were found to be much higher than the actual efficiencies during the rainfall event in most cases.

Coal Strip Mining

TITLE:

Spark-Source Mass Spectrometer Investigation of Coal Particles and Coal Ash

AUTHOR:

T. Kessler, A.G. Sharkey, Jr., and R.A. Friedel

ADDRESS:

Pittsburgh Energy Research Center, Pittsburgh, PA

REFERENCE:

Bureau of Mines Respirable Dust Research Program, Technical Progress Report - 42, September 1971

SUMMARY:

Spark-source mass spectrometry has been used to determine the amounts of minor and trace elements in coal particles of various sizes, including the respirable range (<5 microns). Fifty-six elements ranging in concentration from 0.1 ppm wt to 5,000 ppm wt have been determined. The investigation of coal and coal ash has shown that the organic material in coal does not interfere with the spark-source determination of the various elements.

TITLE:

Debris Basins for Control of Surface Mine Sedimentation

AUTHOR:

Robert L. Kimball

ADDRESS:

Kentucky Department for Natural Resources and Conservation, Frankfort.
Office of Planning and Research. Ebensburg, Pennsylvania. Industrial
Environmental Research Laboratory, Cincinnati, Ohio. Extraction Technology
Branch.

REFERENCE:

PB-255 959/9ST (NTIS)

SUMMARY:

This report discusses effectiveness of debris basins in controlling solids in water discharging from surface mine operations. Two sites in Eastern Kentucky were selected for study in areas where very little erosion-causing activity has occurred and where surface mining is to be initiated. Adjacent virgin watersheds were also selected for each study site to provide background data on water quality where man's activities have been very limited. Pertinent site information including flow and water quality data was gathered.

Coal Strip Mining

TITLE:

Assessment of Water Pollution Caused by Inactive Ore and Mineral Mines

AUTHOR:

Harry W. Martin

ADDRESS:

Toups Corporation, Santa Ana, CA 92711

REFERENCE:

Paper presented at Workshop on Standard Reference Materials for Mine Drainage, National Bureau of Standards, Gaithersburg, Maryland, April 1976.

SUMMARY:

The discharge of mineralized acidic waters from inacitve mines has overloaded the assimilative capacities of may receiving waters creating a distressed environment. To date, no comprehensive assessment has been conducted to determine the extent of this type of pollution. In addition the extent of utilization of pollution control procedures at inactive mines is not known. The Environmental Protection Agency has contracted with Toups Corporation to perform this assessment.

The purposes of this study have been to:

Identify the nature and extent of water pollution caused by inactive ore and mineral mines (pollution problems associated with mining of coal, natural gas, petroleum, and sand and gravel are not included in this study).

Determine state-of-the-art and the use of water pollution prevention and control procedures for inactive mines.

Prepare research and development programs to develop technology to adequately control water pollution caused by inactive mines.

TITLE:

Environmental Aspects of Coal Production in the Appalachian Region. Progress Report, June 1, 1979--May 31, 1976.

AUTHOR:

R.A. Minear; B.A. Tschantz, J.H. Rule; G.L. Vaughn; D.E. Overton

REFERENCE:

ORO-4946-1 (NTIS)

SUMMARY:

Work on the hydrology of surface mine spoil banks is reported, including the mobilization of heavy metals in water (from wells in the spoil banks, ponds, seepage flow, streams, etc.) and in stream sediments. Results are described briefly and metal concentrations are given in tables. Lead, zinc, and possibly chromium were higher in sediments in streams involving strip-mined areas. The biological effects seem to be more significant: Both the total number of organisms and the diversity index were lower in the areas associated with mining activity. Samples have been taken for the analysis of heavy metals and enzyme activities. (ERA citation 01:010251)

TITLE:

Shallow Ground Water in Selected Areas in the Fort Union Coal Region

AUTHOR:

Northern Great Plains Resource Program, Denver, Colorado

ADDRESS:

Geological Survey, Helena, Montana

REFERENCE:

PB-244 848/8ST (NTIS)

SUMMARY:

Three sample areas are ananlyzed to determine potential pollution impacts of surface mining on the shallow ground water systems. Areas analyzed were the southeastern portion or North Dakota, the Gillette area of Wyoming and the Decker-Birney area of Montana. They were selected as representative of areas where accelerated coal mining is likely to occur. The analyses indicates there will be (1) Localized disruptions of aquifers; (2) drainage of adjoining clinker beds; (3) drainage of aquifers in immediate vicinity of mines; (4) underlying aquifers will be little affected; (5) possible increase in nitrate and sulphate concentrations in mine waters; and most importantly (6) contamination of the water resource by dissolved material leached form strip-mining spoils. All problems except pollution of ground water from spoils should be minimal after replacement of spoils and rehabilitation. Ground water pollution could be long term.

Coal Strip Mining

TITLE:

Reclamation of Disturbed Lands in the Lignite Area of the Northern Plains

AUTHOR:

R. W. Ries, F.M. Sandoval, and J.F. Power

ADDRESS:

U.S. Department of Agriculture, Northern Great Plains Research Center,
Mandan, N.Dakota

REFERENCE:

Technology and Use of Lignite Symposium
Grand Forks, N.D. (May 1977) GFERC/IC-77/1 (Page 309)

SUMMARY:

Recommended procedures include premining soil and over burden laboratory analysis, removing and stockpiling suitable soil materials (up to 5 feed if available), removing over burden, extracting coal, reshaping spoil, replacing stockpiled soil material, fertilizing and seeding to either cropland or rangeland mixture of plant species.

If the recommended procedures are followed, the probability for high level reclamation is promising. Some problems still exist for which there is less knowledge -- they include piping erosion, subsidence, need for more reliable vegetation establishment practices, and the assurance of sustained productivity under various land uses.

Current research is directed towards determining soil thickness requirements needed over undesirable mine spoil for permanent reclamation.

Coal Strip Mining

TITLE:

Application of LANDSAT-2 Data to the Implementation and Enforcement of the Pennsylvania Surface Mining Conservation and Reclamation Act.

AUTHOR:

Orivlle R. Russell; David A. Nichols; Richard Anderson

ADDRESS:

Earth Satellite Corporation, Washington, D.C., NASA Earth Resources Survey Program, Washington, D.C.

REFERENCE:

E77-108184 (NTIS)

SUMMARY:

The author has identified the following significant results. Evaluation of LANDSAT imagery indicates severe limitations in its utility for surface mine land studies. Image stripping resulting from unequal detector response on satellite degrades the image quality to the extent that images of scales larger than 1:125,000 are of limited value for manual interpretation. Computer processing of LANDSAT data to improve image quality is essential; the removal of scanline stripping and enhancement of mine land reflectance data combined with color composite printing permits useful photographic enlargements to approximately 1:60,000.

Coal Strip Mining

TITLE:

Coal Recovery from Bituminous Coal Surface Mines in the Eastern Unites States: A Survey

AUTHOR:

Edwin S. Secor; Gary M. Larwood; Arvind B. Gupta; Arthus S. Lees

ADDRESS:

Bureau of Mines, Pittsburgh, Pennsylvania, Eastern Field Operation Center.

REFERENCE:

PB-269 914/8ST (NTIS)

SUMMARY:

The Federal Bureau of Mines conducted a field survey of 153 bituminous coal strip and auger mines to estimate coal recovery from surface mines in the Eastern United States. Recovery was calculated from field data by measuring coal losses resulting from mining coal and leaving barriers. Mean total coal recovery varied only slightly for the two regions studied: 82.7 percent for Appalachian and 84.3 for the Midwest. Total recovery grouped by mining method--contour, area, and mountaintop removal--was 79.8, 84.7, and 85.3 percent, respectively. Mean auger recovery was 35.9 percent; of the total average loss of 64.1 percent, over one half resulted from design limitations while the remainder was attributed to operating losses. The wide recovery range at individual mines indicates the variability of the eastern surface coal mining industry. Because of this, care should be exercised in applying the results of this report to reserve estimates other than those of a general nature.

Coal Strip Mining

TITLE:

Detection of Organic Compounds in Respiratory Coal Dust by High-Resolution Mass Spectormetry

AUTHOR:

J.L. Shultz, R.A. Friedel, and A.G. Sharkey, Jr.

ADDRESS:

Pittsburgh Energy Research Center, Pittsburgh, PA

REFERENCE:

Bureau of Mines Respirable Dust Research Program, Technical Progress Report - 61, October 1972

SUMMARY:

The investigation of organic compounds in respiratory coal dust by high-resolution mass spectrometry has shown that the organic components differ (1) with particle size, (2) with rank of coal, (3) in coals of same rank from different coal seams, and (4) in respirable mine dust and respirable coal dust (prepared) from the same mine.

The eight respirable mine dusts studied are from coal seams in the Appalachian region where the incidence of coal workers' pneumoconiosis is relatively high. The molecular weights of the major organic components vary greatly among these respirable mine dusts; three show strong concentrations of polynuclear aromatic hydrocarbons.

TITLE:

Toxic Effects on the Aquatic Biota from Coal and Oil Shale Development

AUTHOR:

Robert V. Thurston, Principal Investigator; Rodney K. Skogerboe and Rosemarie C. Russo, Co-Principal Investigators

ADDRESS:

Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, Colorado 80523

REFERENCE:

Progress Report - year 1. (July 1975 - June 1976).

SUMMARY:

This report discusses the potential impact on the aquatic environment of four major areas of energy development:

(A) Coal mining; (B) Coal combustion; (C) Coal gasification and liquefaction; (D) Oil shale mining and processing. Each category is treated individually, with the unique features and potential problem areas identified for each of them.

The concept of laboratory bioassy is discussed and how the bioassays are used as a screening tool to establish priorities listed are the publications and technical reports which have been issued since July 1975 on research carried out within this report.

Coal Strip Mining

TITLE:

Heavy Metal Pollutants in Waters of the Front Range Mineral Belt

AUTHOR:

Thomas R. Wildeman

ADDRESS:

Department of Chemistry and Geochemistry, Colorado School of Mines,
Golden, Colorado 80401

REFERENCE:

Presented at the Workshop on SRM's for Mine Drainage National Bureau of Standards, Gaithersburg, MD, April 28-29, 1976

SUMMARY:

Recent studies on the water associated with mining activities in Colorado and particularly in the Front Range Mineral Belt are used to pinpoint the parameters that control the chemistry of the water.

With regard to mining activity, most water of poor quality comes from abandoned mines; drainage from active operations is not necessarily harmful.

With regard to ore petrology, studies of water draining from different zones of mineralization in the Central City Mining District show that water of the poorest quality will be generated where pyrite is a predominant vein mineral.

With regard to ground water hydrology, seasonal studies on at least 9 different drainages in various ore districts in the Front Range show that all of these drainages are recharged by a diffuse flow aquifer system in which the water residence time is on the order of months and the physical and chemical parameters of the water show little response to changes in precipitation and the seasons.

With regard to ore occurance, comparison of drainages from other ore districts with that from Central City show that water from a disseminated ore system will generally be of poorer quality than that from a vein ore system. Also, if much of the ore body occurs above the water table, oxidation of the vein minerals will be promoted which leads to water of poor quality.

Two maintanience guidelines should yield mine effluents of better quality in active mining operations; 1) keep the contact time of the water with the vein minerals as short as possible, and 2) seal the vein minerals from the air whereever possible.

Coal Strip Mining

TECHNICAL REPORTS:
OIL REFINERIES

TITLE:

The Characterization of Trace Organic Constitutents in Petroleum Refinery Wastewater by Capillary Gas Chromatography/Real Time High Resolution Mass Spectrometry - A Preliminary Report

AUTHOR:

[1]A.L. Burlingame, B.J. Kimble, E.S. Scott, D.M. Wilson and J.J. Stasch;
[2]J.W. deLeeuw; [3]L.H. Kieth

ADDRESS:

[1]Space Sciences Laboratory, University of California, Berkeley, CA;
[2]Delft University of Technology, Department of Chemical Engineering and Chemistry, Organic Geochemistry Unit, Delft, The Netherlands; [3]U.S.E.P.A., Southeast Environmental Research Laboratory, Athens, GA

REFERENCE:

"Identification of Organic Pollutants", Chapter 32, p. 587.

SUMMARY:

Due to the extremely complex composition of oil refinery wastewaters, standard techniques such as simple gas chromatography are not sufficient to resolve the mixtures into the individual constituents. This paper deals with the application of a powerful new technique - a combination of high-resolution gas chromatography and real-time high-resolution mass spectrometry- in the analysis of these comples waste effluents. Three general samples were studied: API separator effluent, oxidation pond clarifier effluent, and discharge effluent. Experimental techniques including such pertinent data as GC column type and temperature programming are described in detail.

Many sample mass chromatograms are given along with their analysis. A listing of a variety of oxygen-sulfur-and nitrogen-containing components found in the various fractions is included although it is debatable how far this can be estrapolated in reference to other refinery effluents.

TITLE:

The Synthesis of 5-tert-Butyl-1,2,3,4-Tetrahydronaphthalene

AUTHOR:

J.W. Burnham, W.P. Duncan, E.J. Eisenbraum*, O.W. Keen, and M.C. Hamming

ADDRESS:

*Department of Chemistry, Oklahoma State University, Stillwater, Okla. 74074

REFERENCE:

Organic Preparations and Procedures Int. 5(6), 285-290 (1973)

SUMMARY:

The direct preparation of 5-t-butyl-1,2,3,4-tetrahydronaphthalene from 1-t-butylnaphthalene by catalytic hydrogenation is not feasible since reduction occurs exclusively in the substituted ring. Sodamide reduction of the t-butylnaphthalene leads to a mixture of products in low yield. This paper discusses a method whereby naphthoic acid is hydrogenated, the products are separated, and the 5,6,7,8-tetrahydro-1-naphthoic acid fraction is treated to yield the desired 5-t-butyl-1,2,3,4-tetrahydronaphthalene.

Oil Refineries

TITLE:

Environmental Problem Definition for Petroleum Refineries, Synthetic Natural Gas Plants

AUTHOR:

E.C. Cavanaugh, J.D. Colley, P.S. Dzierlenga, V.M. Felix, D.C. Jones and T.I. Nelson

ADDRESS:

Radian Corporation
8500 Shoal Creek Boulevard
Austin, Texas 78766

REFERENCE:

U.S. Department of Commerce (NTIS)
PB 252 245

SUMMARY:

Information in this report was compiled for the purpose of providing the Environmental Protection Agency with technical support in the area of total environmental problem definition for petroleum refineries, synthetic natural gas (SNG) plants, and liquefied natual gas (LNG) plants.

Process descriptions are presented for each plant. Where applicable, comparisons to other types of energy conversion plants are made. Potential ambient air emissions, liquid effluents, and solid wastes are identified and the status of monitoring methods and control techniques for these emissions and wastes are discussed.

The problem involved with the siting of new plants because of the impact of these emissions and wastes are considered. Areas where research and development can be usefully applied to these environmental problems are identified.

TITLE:

Petroleum Industry Activities in Energy Research and Development

AUTHOR:

Arthur L. Conn

ADDRESS:

Amoco Oil Company
Naperville, IL 60540

REFERENCE:

Proceedings of the 2nd Energy Technology Conference Energy Technology II (page 207) 1975

SUMMARY:

The petroleum industry is funding a broad program of energy research and development ranging all the way from improving traditional methods finding oil and gas to nuclear breeder reators. Making use of its expertise in carrying out advanced, sophisticated R&D and in scaling up from the smallest practical unit to very large plants, the industry is becoming increasingly involved in energy areas not directly related to petroleum. A survey of a broad segment of the industry indicates that while a major part of the effort involves exploring for and producing additional quantities of oil and gas, and recovering oil from tar sands and oil shale, appreciable effort is also involved in such "far out" areas as geothermal and solar energy. Much work is being carried out on coal liquefaction and gasification as well as in nuclear energy -- finding and producing uranium, fabricating and repocessing nuclear fuels, developing new methods of separating uranium isotopes, and development of breeder reactors. A major industry-wide effort is involved in environmental control -- minimizing air pollution from mobile and stationary sources, minimizing water pollution, prevention and control of oil spills, and handling of solid wastes. While much effort has also been expended on conservation using well-known techniques, there is also a appreciable amount of research and development in this area. Thus, the petroleum industry is active in practically every important area of energy research and development.

Oil Refineries

TITLE:

Separation of Anthracene Hydrogenation Products on a Picric Acid Column

AUTHOR:

K.D. Cowan, L.L. Ansell, and E.J. Eisenbraun

ADDRESS:

Oklahoma State University
Stillwater, OK 74074

REFERENCE:

Chemistry and Industry, Nov. 6, 1976

SUMMARY"

Picric acid is widely used as a complexing agent for the purification of aromatic hydrocarbons having a naphthalene or higher fused ring system. Cleavage of this complex has been accomplished with a Soxhlet technique which extracts the hydrocarbon directly from the solid complex. This paper details the authors' work on the construction and capabilities of a modified Soxhlet technique for the separation of the hydrogenation products of antheacene. In this method, the hydrocarbon mixture is percolated through a column of picric acid using isohexane solvent. Recovery of 1,2,3,4-tetrahydroanthracene was of the order of 69% and had a purity of 99%.

TITLE:

Matrix Isolation Fourier Transform Infrared Spectrometry of Polycyclic Aromatic Hydrocarbons

AUTHOR:

Gleb Mamantov, E.L. Wehry, R.R. Kennerer, and E.R. Hinton

ADDRESS:

Department of Chemistry, University of Tennessee
Knoxville, TN 37916

REFERENCE:

Analytical Chemistry, 49, 86 (1977)

SUMMARY:

The application of matrix isolation Fourier transform infrared spectroscopy to qualitative and quantitative analysis of polycyclic aromatic hydrocarbons (PAH) is described. Samples in nitrogen matrices at ∿15 K are produced by mixing the PAH vapors effusing from a Knudsen cell with a large excess of nitrogen gas. From the results obtained with nearly 20 PAH, analysis of moderately complex mixtures (∿10 components) appears feasible. The applicability of Beer's law to matrix-isolated PAH samples over a large concentration range has been demonstrated. A detection limit of 0.5 μg of perylene (2×10^{-9} mol) has been achieved.

TITLE:

Heavy Metals in Water, Sediments, and Chironomids in a Stream Receiving and Oil Refinery Effluents

AUTHOR:

Harold E. Namminga, Ph.D.

ADDRESS:

Oklahoma State University

REFERENCE:

Diss Abst. B, 1776, 36110 (4855-B) Ca 85 (16) 112397

SUMMARY:

Scope of Study: Distribution of copper, chromium, lead, and zinc in water, sediments, and chironomids was studied in a stream receiving oil refinery and municipal sewage effluents. The objectives of this study were to (1) measure the concentrations of four heavy metals in water, sediments, and chironomids in Skeleton Creek; (2) estimate accumulation of heavy metals in sediments and chironomids above levels in water; (3) determine if cool and warm season conditions change the distribution of heavy metals in water, sediments, and chironomids; (4) determine the effect of high discharge on concentrations of high discharge on concentrations of metals in water and sediments; and (5) determine if oil refinery equipment cleaning increases the concentrations of metals in water and sediments.

TITLE:

The Biological Treatment of Waste Waters in Oil Refineries

AUTHOR:

POP, Victor, I., Ionescu-Homoriceau, Serban, I

REFERENCE:

Rev. Chim (Bucharest) 26. 56, 1975

SUMMARY:

The waste waters from oil refineries contain very high concentrations of phenols H_2S, and mercaptans. Although most of these pollutants are removed by physical stripping or coagulation the remaining levels are too high to be released into receiving waters. By using an activated sludge and by applying a 2-gradient purifn, method, the concentration of the pollutants can be reduced to a permissible value. Thus, the phenols content decreased to 0.6 mercaptans 0.7-1.9 mg/l.

Oil Refineries

TITLE:

Evaluation of Waste Waters form Petroleum and Coal Processing

AUTHOR:

Professor George W. Reid and Dr. Leale E. Streebin

ADDRESS:

Robert S. Kerr Water Research Center
Environmental Protection Agency
P. O. Box 1198
Ada, Okla. 74820

REFERENCE:

EPA-R2-72-001, December 1972

SUMMARY:

This report presents an evaluation on pollution problems, abatement procedures and control techniques relevant to the petroleum and coal industries. Petroleum wastes are discussed under three broad sections: Drilling-Production, Transportation and Storage, and Refining. Each section is introduced with background information. Within each section, petroleum wastes are identified as to their source, volume, and composition, and waste treatment methods are discussed.

The results of a field study of three small refineries are reported, providing additional information which delineates the characteristics of waste streams from individual processes within the refinery.

Coal mining, coal processing, and coal utilization, the wastes associated with each, and the corresponding control measures are discussed. Acid mine drainage, the most significant pollution problem from coal mining, and possible control measures are presented. The major pollution problems associated with coal processing originate from coal cleaning, the coking process, and refuse disposal. The principal pollutants in water discharged from the processing of coal are suspended solids usually in the form of fine clay, black shale, and other minerals commonly associated with coal.

TITLE:

Basic Research Needs for Tertiary Oil Recovery

AUTHOR:

R.S. Schechter and W.H. Wade

ADDRESS:

University of Texas at Austin, TX

REFERENCE:

Proceedings of a National Science Foundation Workshop held in Austin, TX on June 26-27, 1974.

SUMMARY:

The aim of this workshop was to define that fundamental research needed to achieve technically and economically feasible methods of enhancing oil recovery. Six main problems were studied: (1) Low Tensions: what we know and what we need to know, (2) Polymer Floods: persisting problems, (3) Micellar Floods: fundamental questions, (4) Adsorption of Surfactants: can it be reduced? (5) Thermal Recovery Methods: unresolved issues, and (6) Measurement of Residual Oil: the basic question involves our petroleum reserves.

TITLE:

Hydrocarbon in Sewage and Urban Runoff - Delaware Estuary

AUTHOR:

The Water Resources Research Institute, Department of Environmental Sciences, and Department of Civil and Environmental Engineering, Rutgers University

REFERENCE:

Proceedings of the Symposium on Sources, Effects and Sinks of Hydrocarbons in the Aquatic Environment, American Institute of Biological Sciences, Washington, D.C., Aug. 9-11, 1976.

SUMMARY:

Research has been conducted to identify and measure the sources of hydrocarbons entering the Delaware Estuary. The most important sources of petroleum pollution have been industrial wastes; but currently mandated treatment measures will greatly reduce such outputs, especially those of petroleum refineries. Municipal sewage effluent has been sampled and analyzed. Methods have been developed to sample storm runoff from urban areas at frequent intervals and to use the analysis of these samples to estimate total annual petroleum loadings. Major petroleum pollution above water supply intakes is hazardous. Evaluation of sources appears likely to change pollution control strategy.

TITLE:

Environmental Objectives and Water Quality Control Programs

AUTHOR:

William Whipple, Jr.

ADDRESS:

Water Resources Research Institute, Rutgers University, New Brunswick, NJ

REFERENCE:

Wildlife Management Institute, Transactions of the 41st
North American Wildlife and Natural Resources Conference, 1976.

SUMMARY:

In this report, present requirements for effluent treatment and those which will be required by federal law in coming years are analyzed in terms of an overall environmental objective which takes into account both attainable environmental quality and realistic economics. The opinion that present views on environmental controls is inadequate and short sighted is put forward and such ideas as regional environmental objectives vs. nationwide objectives, control of nonpoint source pollution, and alternatives to potentially hazardous or economically unfeasible treatment systems, are advocated as the only realistic environmental objectives.

TECHNICAL REPORTS:
OIL SHALE OPERATIONS

TITLE:

Polycondensed Aromatic Compounds (PCA) and Carcinogens in the Shale Ash of Carbonaceous Spent and Shale from Retarting of Oil Shale.

AUTHOR:

J.J. Schmidt-Cillevus, F. Bonomo, Kishor Gala, and LaRose Leffler

ADDRESS:

Denver Research Institute, Denver, Colorado 80210

REFERENCE:

Science and Technology of Oil Shale, 1976, p. 115-156.

SUMMARY:

The objective of this investigation was to determine experimentally possible specific physical environmental effects from solid carbonaceous material from an oil shale industry, the full-scale impact of which might only be felt many years after full operations have begun. Consequently, these investigations rely on material and data obtained from rather small pilot plant operations. With the foreseeable development of actual larger-scale demonstration plants (about 50,000 barrels of oil per day, these investigations appear timely and might contribute some new experimental data useful for a better evaluation of potential environmental problems.

TITLE:

The BER Balanced Program Plan: Oil Shale Technology

AUTHOR:

H.F. Schulte, A.K. Stoker, E.E. Campbell, E.C. Aderson, G.E. Dials

ADDRESS:

Los Alamos Scientific Laboratory, Los Alamos, NM 87545

REFERENCES:

U.C. 91, June 1976

SUMMARY:

Oil shale technology has been divided into two subtechnologies: (A) Surface Processing and (B) In situ Processing. Definition of the research program is essentially an amplification of the five King-Muir categories: (A) Pollutants: Characterization, Measurement, and Monitoring; (B) Physical and Chemical Processes and Effects; (C) Health Effects: (D) Ecological Processes and Effects: and (E) Integrated Assessment.

TITLE:

Leachability of Arsenic, Selenium, Molybdenum, Boron, and Fluoride From Retorted Oil Shale

AUTHOR:

Stellenwerk, K.G., and D.D. Runnells

ADDRESS:

University of Colorado, Boulder

REFERENCE:

AIChE, New York, NY, 1977 Vol. 2

SUMMARY:

Leachability of selected trace elements in retorted oil shale was studied in order to determine the potential for water pollution. Arsenic, selenium, molybdenum, boron, and fluoride were chosen because they may occur as soluble anions under the pH conditions (8-12) of water associated with retorted shale. Spent shale samples, from the Mahogany Zone and prepared by the TOSCO II process, were employed. The material is characterized by silt-size grains that are coated with carbon. Shaker and column experiments were designed in order to test the mobility of the elements. Maximum concentrations (mg/l) in retorted shale leachates from six column experiments ranged from 11-20 (B), 8.4-4-14.5 (B), 8.8-11.8 (Mo), .03-.04 (As), and .02-.03 (Se). Total dissolved solids ranged from 7,300-14,200 mg/l and pH from 8.3-8.7. Hydraulic conductivity ranged from 1.7×10^{-5} to 3.7×10^{-4} cm/sec. 10 refs.

TITLE:

Water Conservation with In Situ Oil Shale Development

AUTHOR:

Jerome F. Thomas, _et_. _al_.

ADDRESS:

Department of Civil Engineering, Division of Sanitary Engineering, University
of California, Berkerly, Berkerly, California 94720

SUMMARY:

In situ oil shale facilities generate various types of wastewater including (1) retort water, (2) wastewater from upgrading processes, and (3) sanitary sewage. Untreated, partially treated, and treated wastewater produced by in situ oil shale operations will be disposed of in one or more of the following ways: discharge to surface waters, injection into groundwater aquifers, land disposal, and discharge to evaporation ponds. Major contaminants of waters used and generated by oil shale production will be high levels of BOD/COD, ammonia, soluble organics, and TDS.

It is proposed to assess the effects of retort water from in situ oil shale processing on lotic freshwater aufwuchs. A laboratory analog model in which environmental variables can be controlled will be used to monitor aufwuchs responses to retort water. Actual retort water and some fractionated components will be bioassayed in this study.

Various wastewaters and effluents will be characterized for all pertinent components. A complete water cycle for in situ oil shale production will be developed including water demand, water production, and water loss. Other environmental impact areas, such as nutrient rich runoff from revegetative dump sites, will be assessed.

TITLE:

Factors that Influence the Leaching of Organic Material from In Situ Spent Sahle

AUTHOR:

Amy, Gary, and J. Thomas

ADDRESS:

University of California, Lawrence Berkeley Lab

REFERENCE:

AIChE, New York, NY, 1977 Vol. 1

SUMMARY:

In the reported study, a series of batch and continuous flow experiments were run in order to assess the potential for contamination of groundwater by organic material leached from in situ spent shale. The specific objectives of these experiments were to 1) estimate the concentration of organic material present in leachate derived from various types of in situ spent shale, and 2) identify variables that affect the concentration of organic materials in leachate. Concentrations of total organic carbon (TOC) as high as 50 milligrams per liter were detected during experimentation. Factors that significantly influenced the concentration of organic material present in leachate included 1) retorting conditions associated with spent shale, 2) spent shell particle size, 3) water temperature, and 4) leaching time. 4 refs.

TITLE:

Trace Elements Associated with Oil Shale and it's Processing

AUTHOR:

TRW
Los Angeles, California
DRI
Denver, Colorado

REFERENCE:

EPA 908/4-78-003

SUMMARY:

This report includes a summary of existing trace element composition data for shale and its products, an evaluation of these data and related studies to estimate the distribution of trace elemtnts among shale products during oil shale processing, and predictions of the disposition and ultimate fate of trace elements after waste disposal or product use. Wide ranges in trace element concentration reflect natural geographic and veritifical profile variations in shale.

TITLE:

Oil Shale Development

AUTHOR:

Paul Wellman

ADDRESS:

Ashland Oil, Inc., P.O. Box 391, Ashland, Kentucky 41101

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering Conference Proceedings, 1, 331 (1976).

SUMMARY:

This paper discusses the events leading to the significant decisions that have been made concerning oil shale development and includes such topics as economics, the political pressures, environmental, OPEC pricing, new discoveries and conservation, technology, and social aspects and local economy.

TITLE:

Environmental Sampling of the Paraho Oil Shale Retort Process at Anvil Points

REFERENCE:

Technology Transfer EPA 625/9-77-002

SUMMARY:

The analysis of recycle gases included measurements of H_2S and NH_3. In either the direct or indirect mode of a commercial operation, the need for NH_3 and H_2S removal can be anticipated before a recycle purge stream is used as fuel. Some other postulated species were not detected. The recycle gas was found to contain no COS, CS_2, HCN, or AsH_3.

Condensate water inorganics appear to contain essentially ammonium carbonate and bicarbonates. Trace elements were not significant in the condensates. Trace organics were found in the retorted shale, condensate, and product water; the range of compounds included organic neutrals (particularly aromatics), organic acids, and organic bases.

TITLE:

Petroleum, Natural Gas, and Oil Shale Technology

AUTHOR:

H. Neal Dunning

ADDRESS:

Division of Petroleum, Natural Gas, and In Situ Technology, Energy Research and Development Administration, Washington, D.C.

REFERENCE:

Energy Technology II, Proceedings of the 2nd Energy Technology Conference, J.F.P. Sullivan, Ed., (Government Institutes, Inc., Washington) 1975. p. 40.

SUMMARY:

This report discusses some aspects of future technology which will aid in the utilization of certain energy sources which at the present time is technologically and more often, economically non-feasible. Included in this discussion is tertiary oil recovery, which could become a major source of energy, in situ processing of oil shale, and in situ coal gasification. A summary of the major government-supported research programs in each of these areas is also given.

TITLE:

The Toscoal Process - Pyrolysis of Western Coals and Lignites for Char and Oil Production

AUTHOR:

Mark T. Atwood and Bernard L. Schulman

ADDRESS:

Tosco Corporation, 18200 West Highway 72, Golden, Colorado 80401

REFERENCE:

American Chemical Society, Division of Fuel Chemistry. Preprints, 22 (2), 233 (1977)

SUMMARY:

Toscoal processing of coal is based on technology acquired in twenty years of continuous work on the Tosco II oil shale retorting process. Coals of low rank can be used directly. Those of higher rank may be retorted after treatment with air and steam to effect decaking.

Processing of Western coals and lignites is of interest in reducing the large freight costs currently involved in transporting moisture and non-combustible components. Use of chars rather than coal as utility boiler fuels offers investment and operating cost advantages. Chars produced may also be used in the manufacture of formcoke and as an improved feedstock in gasification.

Liquid products may be used as a fuel, and as a source of chemicals, coke and pitch binders.

High heating value gas is produced as a coproduct.

TITLE:

Trace Elements in Oil Shale

AUTHOR:

W.R. Chappell, D. Runnells; co-principal investigators
R. Klusman, T. Wildeman, W. Lindsay, H. Walton, R. Meglen; senior investigators.

ADDRESS:

Environmental Trace Substances Research Program, Ekely Chemistry
M335, University of Colorado, Boulder, Colorado 80309

REFERENCE:

Environmental Trace Substance Research Program, Progress Report for period June 1, 1976 - May 31, 1977, COO-4017-1

SUMMARY:

During the initial year of funding a substantial number of samples of water, stream sediment, soils, plants oil shale, spent shale, shale oil and other materials were collected by the investigators for analyses. A considerable amount of effort was also involved in the development and validation of methods for preparing and analyzing these samples for trace element content. Among the results are:

1. Cu, Li, and Zn exhibit well-defined trends in soils over the Piceance Basin, with values increasing from north to south.
2. As, Mo, B, and Se are all elevated in the soils of the Piceance Basin.
3. Mo and B are more soluble in TOSCO spent shale than in unprocessed shale and are also elevated in plants growing on spent shale.
4. F is less soluble in spent (TOSCO) shale than in unprocessed oil shale, but nevertheless, the levels in leachates are quite significant (25 mg/ℓ). Moreover, the F is not readily leached out.
5. Results to date show that As and Se are not very soluble in spent shale (TOSCO) and are not taken up to a significant extent by plants.

TITLE:

Sampling and Analysis Research Program at the Paraho Shale Oil Demonstration Plant

AUTHOR:

J.E. Cotter, C.H. Prieu, J.J. Schmidt-Collerus, D.J. Powell, R. Snug, C. Habenicht, and R.E. Pressey

ADDRESS:

TRW Environmental Engineering Division
Redondo Beach, California 90278

SUMMARY:

A sampling and analysis research program was conducted at the Paraho oil shale retorting demonstration site at Anvil Points, Colorado. The work was carried out the TRW and the Denver Research Institute. The overall objective of the test program was to obtain preliminary quantitative and qualitative measurements of air, water, and solid compositions, and to gain experience that would lead to improved sampling procedures and the determination of priorities for sampling and analysis of shale oil recovery operations.

The existing Anvil Points operations include two vertical retorts: a large semi-works unit in which a portion of the off-gas was recycled and heated externally to supply heat to the retort and a smaller pilot plant in which air was introduced with recycle gas to support combustion of carbon on retorted shale as a resource of process heat. The test plan included both retorts, as their process streams (with the exception of oil product) are essentially different. Selection of sample locations was based on need for information on process streams relative to emissions and effluents expected in a full-scale plant.

Samples taken included the recycle gases (H_2S, SO_2, NO_x, NH_3, and trace organics), recycle condensate, product oil/water, processed shale discharged from the retorts, and dust in the vicinity of crushing, screening, and conveying equipment. A variety of laboratory analysis methods were used, including wet chemical analysis, spark source mass spectormetry, high pressure liquid chromatography, thin layer chromatography, gel permeation chromatography, and gas chromatography/mass spectrometry methods (GC/MS).

Condensate water inorganic analyses were done for calcium magnesium, sodium and potassium salts, ammonia, gross parameters, and trace elements. Condensate and product water samples were also analyzed for organic neutrals (particularly aromatics), organic acids, and organic bases. Elemental determinations of both retorted shale and raw shale particulates were made.

This report was submitted in partial fulfillment of Contract 68-02-1881 by TRW Environmental Engineering Division under the sponsorship of the U.S. Environmental Protection Agency. This interim report covers the period of June 1, 1975 through December 1, 1976, and work is continuing.

Oil Shale Operations

TITLE:

In Situ Recovery of Oil and Minerals from Piceance Creek Basin Oil Shale

AUTHOR:

J.O. Cowles and E.M. Boughton

ADDRESS:

Energy Systems Group of TWR Inc., McLean Virginia

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering Conference Proceedings
1976 Vol. I.

SUMMARY:

This paper discusses an in situ process for recovering shale oil from the salt capped shale deposit at the depocenter of the Piceance Creek Basin in Colorado. The operations in this process are tailored to this specific deposite. The deposit lies beneath a thick overburden and cannot be economically recovered by conventional mining and surface retorting. The formation is gas tight, free of aquifers and rich in soluble salts, making it a likely candidate site for a successful demonstration of in situ recovery techniques. The salt capped region is estimated to contain over 50 billion barrels of oil in place. The potential oil recovery by this process is 10-20 billion barrels of oil. In addition substantial by-product soda ash and aluminum ore are recovered.

The paper further described in some detail a proposed development program designed to assess the commercial feasibility of the process.

TITLE:

A Preliminary Assessment of the Environmental Impacts From Oil Shale Developments

AUTHOR:

K.W. Crawford, C.H. Prien, L.B. Baloolal, C.C. Shih and A.A. Lee

ADDRESS:

TWR Inc.
One Space Park
Rendondo Beach
California, 90278

Denver Research Institute
P.O. Box 10127
Denver, CO 80210

REFERENCE:

PB 272 283 (NTIS)

SUMMARY:

The report is a summary of major oil shale extraction and retorting development activities. The potential impacts on the physical environment which could result from commercial oil shale development are discussed relative to sources, properties, and quantities of wastes. The report describes existing air, water, and land resources in northwestern Colorado and northeastern Utah. The identification of potential impacts of oil shale development on these resources, pollution control technologies and management plans are reviewed. Potential hazards associated with refining and end use of shale oil products are evaluated. The major environmental monitoring and impact studies are identified, and the scope of oil shale development projects is assessed by this document.

TITLE:

A Preliminary Assessmant of the Environmental Impacts From Oil Shale Developments

AUTHORS:

K.W. Crawford, C.H. Prien, L.B. Baboolal, C.C. Shih and A.A. Lee.

ADDRESS:

TRW, Inc.
Ine Space Park
Redondo Beach, California 90278

REFERENCE:

EPA-600/7/77-069 NTIS

SUMMARY:

The report is a summary of major oil shale extraction and retorting development activities. The potential impacts on the physical environment which could result from commercial oil shale development are discussed relative to sources, properties, and quantities of wastes. The report describes existing air, water and land resources in northwestern Colorado and northeastern Utah. The identification of potential impacts of oil shale development on these resources, pollution control technologies and management plans are reviewed. Potential hazards associated with refining and end use of shale oil products are evaluated. The major environmental monitoring and impact studies are identified, and the scope of oil shale development projects is assessed by this document.

TITLE:

Mercury in Oil Shale from the Mahogany Zone of the Green River Formation, Eastern Utah and Western Colordo.

AUTHOR:

Donnell, J.R., and V.B. Shaw

REFERENCE:

J. Res US Geol Surv Vol. 5

SUMMARY:

Mercury has been reported in concentrations as high as 4 parts per million from oil shale in the Green River Formation near the Federal oil-shale prototype lease-tracts U-a and U-b in eastern Utah. This high concentration of mercury if present throughout a minable zone, would be of concern in commercial oil-shale operations processing large volumes of shale. Using an improved analytical method, surface samples from eastern Utah previously reported to contain high concentrations of mercury were reanalyzed, and an additional 183 drill core samples from the Mahogany zone and adjacent beds were analyzed. The reanalyzed samples averaged slightly more than 0.35 ppm mercury and the drill-core samples averaged 0.37 ppm. The products from a Fischer assay of 100-gram sample of oil shale, found to yield 35 gallons per ton of oil and 43 ppm of mercury, were analyzed for their mercury content. The spent shale contained only 2 percent of the total mercury in the assay products and the gas fraction contained about 58 percent. 4 refs.

TITLE:

Oil Shale and the Environment

AUTHOR:

Environmental Protection Agency

REF:

EPA-600/9-77-033

SUMMARY:

This is a report about an American energy resource, oil shale. It is also a report about the environment and the environmental changes that an oil shale industry could bring about. This subject is currently surrounded by controversy, unresolved issues, conflicting interests, and uncertainties.

There is an urgency to produce more domestic oil as existing supplies dwindle and world oil prices rise. But what we know about the environmental consequences of oil shale development is sparse and often speculative. However, we do know that a relatively small region of the country will have to bear the full burden of these environmental consequences. So--two issues become basic to the future of oil shale:

> Should the resource be developed now with all of the attendant environmental risks, or can we afford to wait until we find out more about the risks and their prevention?
>
> And
>
> Is it fair to trade local lifestyle for the national good?

The purpose of this report, then, is to put oil shale development into a realistic environmental perspective and to describe what the government is doing to insure that development does not exact an intolerable environmental price.

TITLE:

Acquisition, Processing and Storgae for Environmental Research of Aqueous Effluents Derived from In Situ Oil Shale Processing

AUTHOR:

Farrier, D.S., R.E. Poulson, Q.D. Skinner, J.C. Adams, and J. Bower

ADDRESS:

US ERDA, Laramie Energy Res Cent, Wyo

REFERENCE:

AIChE, New York, NY, 1977 Vol. 2

SUMMARY:

A relatively large volume (12,450 gallons) of water significant to oil shale processing by in situ combustion was required to carry out environmental studies at the U.S. ERDA Laramie Energy Research Center. This effluent is a relatively scarce commodity for research purposes. This paper is concerned with the identification of problems and the solutions to problems associated with the acquisition, processing and storage of a large stock reserve of environmental research water. Special attention is given to the practical aspects of field collection procedures, processing by filtration to remove suspended materials, and mitigation of chemical instability induced by microbial degradation of dissolved components. 8 refs.

TITLE:

High Performance Liquid Chromatographic Characterization of Oil Shale Retort Waters

AUTHOR:

Felix, W.D., D. S. Farrier, R.E. Poulson

ADDRESS:

Battelle Pac Northwest Lab, Richland, Wash

REFERENCE:

AIChe, New York, NY, 1977 Vol. 1.

SUMMARY:

Analytical procedures are required for the rapid, quantitative determination of organic solute alteration in oil shale retort water which may occur through photolytic, thermal, chemical and microbial action. High performance liquid chromatographic separations of retort water solutes were optimized using selected eluants on 25 cm bonded phase columns. RP8 (reverse phase, long chain hydrocarbon bonded) columns of high theoretical plate capacity (10,000 to 40,000 plates/meter) with programmed gradient elution provided adequate resolution to obtain left double quote fingerprint right double quote spectra against which comparisons may be made of spectra from altered retort waters. 6 refs.

TITLE:

The Impact of Energy Development on Water Resources in the Upper Colorado River Basin

AUTHOR:

Marshal Flug, Wynn R. Walker, Gaylord V. Skogerboe and Stepeen W. Smith

ADDRESS:

Agricultrual and Chemical Engineering Department,Colorado State
University, Fort Collins, Colorado, 80523

REFERENCE:

PB 273-017

SUMMARY:

A mathematical model which simulates the salt and water exchange phase of potential fuel conversions has been developed based on a subbasin analysis identifiying available mineral and water resources. Potential energy developments are evaluated with respect to the resulting impacts upon both the quanitity and salinity of the waters in the Colorado River. Model solutions are generated by use of multilevel minimum cost linear programming algorithm, minimum cost refering to the cost of developing predetermined levels of energy output. Level one in the model analysis represents an aggregation of subbasins along state boundaries and thereby optimizes energy developments over the five states of the Upper Colorado River Basin. In each of the five second level problems, energy developments over a subbasin division within the respective states are optimized. A generalized solution format is used so that changes can be made to the model which enable its application to other watersheds.

TITLE:

Chemical Characterization and Analytical Considerations For an In-Situ Oil Shale Process Water

AUTHORS:

J. P. Fox
D. S. Farrier and R. E. Poulson

ADDRESS:

Lawrence Berkeley Laboratory, Berkeley, CA 94720
Laramie Energy Research Center, Laramie, WI 82071

SUMMARY:

This study has shown that standard analytical methods cannot be used to determine most water quality parameters in complex waters such as oil shale process waters. Methods specific to each type of water need to be developed and published. Instrumental methods generally produce more accurate results as these encounter fewer interferences than chemical methods. However, significant variation and error can results from differences in sample preparation and the fact the most of these techniques produce precision data for a subset of the total set of elements reported.

Extensive experimental work is required to develop analytical methods to routinely measure cyanide, COD, phenols, orthophosphate, solids, and sulfide in this type of water. Existing methods for the measurement of sulfate, inorganic carbon, ammonia, and some sulfur species and the methods presented in this work for $CO_3^=$, HCO_3^- may be adequate and require additional laboratory testing.

The instrumental methods are relatively free of interferences with the exception of the high sodium concentration. SSMS consistently produced the lowest detection limits but had the poorest precision of all instrumental methods evaluated. XRF and NAA both produced precise and accurate results. AA was successfully used to measure the elements Ca, Mg, Fe, Na, Si, As, K, Se and Zn.

TITLE:

Production of Synthetic Crude from Crude Shale Oil Produced by in Situ Combustion Retorting

AUTHOR:

C.M. Frost, R.E. Poulson, and H.B. Jensen

ADDRESS:

U.S. Energy Research and Development Administration
Laramie Energy Research Center
Laramie, WI   82071

REFERENCE:

Advances in Chemistry Series, Number 151, Shale Oil, Tar Sands, and Related Fuel Sources

SUMMARY:

The purpose of the present study was to test various modern hydrogenation catalysts for their effectiveness in removing nitrogen from in situ crude shale oil fractions and to determine the feasibility of producing a synthetic crude oil that would meet the specifications for syncrude suggested by the NPC. Six modern hydrogenation catalysts were tested to compare their efficiencies in removing nitrogen from a heavy (600°-1000°F) in situ gas oil. The best catalyst, nickel-molybedenum-on-alumina, was used in preparing fractions of a synthetic crude using the methods suggested by NPC.

TITLE:

Direct Analysis of Organic Compounds in Aqueous By-Products from Fossil Fuel Conversiton Processes: Oil Shale Retorting Synthane Coal Gasification and Coed Coal Liquefaction

AUTHOR:

Ho, C.H., B.R. Clar, and M.R. Guerin

ADDRESS:

Oak Ridge Natl Lab, Tenn.

SUMMARY:

Whole water samples are injected directly into a gas chromatograph equipped with a packed Tenax-GC column. Polar compounds are separated with good resolution under the temperature programming conditions employed. The by-product water from oil shale retorting contains carboxylic acids in the homologous series ranging from acetic to decanoic acid. Various amides, cresols and phenol are present in trace amounts. Coal conversion by-product waters also contain carboxylic acids, but in trace amounts (except acetic). Major components among the dissolved organics in coal conversion samples are phenol, o-cresol, m-cresol and p-cresol. Present at lower levels are several other alkyl substituted phenols and napthols. 16 refs.

TITLE:

Research and Developemnt Program on the Disposal of Retorted Oil Shale--Paraho Oil Shale Project

AUTHOR:

W.G. Holtz

ADDRESS:

Woodard-Clyde, Consultants
Development Engineering, Inc.
Anvil Points
Rifle, Colorado 81650

REFERENCE:

PB 253 598 (NTIS)

SUMMARY:

This report contains information on the physical and chemical properties of retorted shale waste material which would be representative of materials that would be produced during oil shale prototype plant retorting operations. Comparisons are made between physical properties determined on both newer and old shale.

TITLE:

Research and Development on the Program of Retorted Oil Shale-Paraho Oil Shale Project

AUTHOR:

W.G. Holtz

ADDRESS:

Woodard Clyde Consultants
Development Engineering Inc.
Anvil Points, Rifle, Co. 81650

REFERENCE:

PB 253 599 (NTIS)

SUMMARY:

This report contains information on the physical and chemical properties of retorted oil shale waste material produced in the semi-works retort which would be representative of materials that would be produced during prototype plant operations. Comparison of those results and those obtained from the pilot plant retroted shale (Phase III, Part I) are made to study the scale-up efforts.

TITLE:

Retorting of Single Oil Shale Blocks with Nitrogen Air

AUTHOR:

Edward T.S. Huang

ADDRESS:

Gulf Research and Development Company, Pittsburgh, Pennsylvania

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering Conference Proceedings
1976 Vol. I.

SUMMARY:

Experiments on retorting single oil shale blocks were carried out in this study to investigate the anomalous fast internal heating phenomenon reported by the other investigators. Two 0.156 l/kg (37.5 gal/ton) oil shale polyhedral blocks (approximate diameter of 18 cm or 7.1 inches) having almost identical organic content and lithological properties were heated at atmospheric pressure to 500°C (932°F) with a carrier gas flow rate of 60 l/hr (2.1 SCR/hr). Carrier gas for one test was air and the other was nitrogen, while all the other experimental parameters were the same. The experimental results showed that the thermal behavior was the same for both runs and no anomalous fast internal heating was observed. A third run with air at a higher flow rate (173 l/hr or 6.1 SCF/hr) also showed no sign of fast heating.

Production of oil and gas was essentially completed in 5 hours under the heating mode of this study. Oil recovery efficiency ranged between 80 to 91% Fischer assay. For the runs with air as a carrier gas, oxygen was efficiently utilized in the retorting process. About on hour after the heating started, almost no oxygen was detected in the effluent. The oxygen penetration into the shale was 1.5 cm (0.6 inches) or less.

TITLE:

Characteristics and Possible Roles of Various Waters Significant to *In Situ* Oil Shale Processing

AUTHOR:

L.P. Jackson, R.E. Poulson, T.J. Spedding, T.E. Phillips, and H.B. Jensen

ADDRESS:

Laramie Energy Research Center, Energy Research and Development Administration, Laramie, WI 82071

REFERENCE:

Quarterly of the Colorado School of Mines, 70, No. 4 (1975)

SUMMARY:

An *in situ* oil shale development program requires consideration of water produced with oil retorting oil shale and of natural waters significant to oil shale processing. These waters may be heavily laden with organic, inorganic, or both types of constituents and must be considered for feasibility of use, storage or disposal in environmentally acceptable ways. Analyses of such waters are presented. Compositions are shown for a variety of simulated *in situ* retort-produced waters. Compositions of natural underground waters occurring in potential *in situ* development areas in the Upper Green River Basin of southwestern Wyoming are presented. Retort-produced waters contain as much as 2 percent organic and 5 percent inorganic constituents and may be produced in volumes in excess of that of the oil. Natural waters of significance may contain over 5 percent inorganic and 5 percent organic components.

TITLE:

Chemical Characterization of Shale Oil and Related Fuels

AUTHOR:

P.W. Jones, R.J. Jakobsen, P.E. Strup and A.P. Graffeo

ADDRESS:

Battelle, Columbus La, Ohio

REFERENCE:

Am Chem Soc Div Fuel Chem Prepr 1976 Vol. 21

SUMMARY:

This paper presents results of a preliminary analytical survey of the organic constituents of shale oil, synthoil, and Prudhoe Bay crude oil, as a prelude to the comprehensive analytical intercomparison which will be reported subsequently. The analytical techniques employed in this study are liquid chromatography (LC), Fournier transform IR spectroscopy (FTIR), and gas chromatographic-mass spectrometry (GC-MS). The analytical procedures used are similar to those described in a recent EPA publication, "Technical Manual for Analysis of Organic Materials in Process Streams", with regard to Level I analysis. Seven chromatographically separated fractions were characterized by FTIR technique. It is shown that synthoil is by far the most aromatic in character and shale oil exhibits the greatest extent of branching in the aliphatic side chains. Shale oil contains the greatest proportion of carbonyl compounds, with synthoil containing the least. Each of the oils contains phenols, and to a lesser extent amino compounds, in similar amounts to each other. 2 refs.

TITLE:

Literature Study of Oil Shale, December 1975

AUTHOR:

H. Kroepelin and J. Ober-Sundermeyer

ADDRESS:

Technische Universität Braunschweig Institut für Chemische Technologie

REFERENCE:

ERDA, n 76-33604

SUMMARY:

In a literature study, in which all the literature available on oil shale deposits and the economic feasibilities within scope of mineral oil exploration are dealt with. The oil shale deposits in the Federal Republic of Germany are described in a comprehensive manner, and efforts made in the years between 1930 and 1945 in connection with oil shale utilization in Germany are illustrated. European and overseas deposits are dealt with and, in addition, facts are given concerning tar sands, lignite, and carbonaceous shales, and torbanite. The properties of different oil shales in the Federal Republic of Germany and those of worldwide deposits are specified in tables showing in detail the chemical knowledge on oil shale, ash content, content of organic matter, calorific value, composition, and methods for isolating the organic substance. All known processes of low-temperature distillation, gasification and degasification of oil shale are mentioned as well as processes for the thermal treatment, underground low-temperature distillation, and distillation according to most diversified methods. The ultimate product of shale oil, its properties, and the various methods of processing are discussed in detail. Utilization of the residues obtained in connection with low-temperature oil shale distillation is referred to and examples cited from Europe and overseas countries. The only oil shale plant still in operation in the Federal Republic of Germany, Portiandzementwerke Dotternhausen, is referred to in detail as a particularly good example; in this plant, the problem of utilizing the residues has been solved. A comprehensive bibliography is included.

TITLE:

Environmental Impacts of Oil Shale Development

AUTHOR:

David L. Meyers *et al*

ADDRESS:

Stanford Research Institute International
Center for Resource and Environmental Systems Studies
333 Ravenwood Avenue
Menlo Park, California 94025

REFERENCE:

PB-276 617 (NTIS)

SUMMARY:

The purpose of this report is to put oil shale development into a realistic environmental perspective, and to describe what the government is doing to insure that development does not exact an intolerable price.

TITLE:

In Situ Combustion of Michigan Oil Shale: Current Studies

AUTHOR:

Dr. William N. Musser and Dr. John H. Humphrey

ADDRESS:

Hydrocarbons and Energy Research Laboratory, Dow Chemical Co., Midland
Michigan 48640

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering Conference Proceedings
1976 Vol. I.

SUMMARY:

Eastern oil shales represent a vast reserve of energy and chemical feedstocks. Michigan's known deposits represent 2.5 trillion barrels in place - about 60 times the nation's oil reserves. The Dow Chemical Company has been involved with this resource for about 20 years. The current effort is focused on the combustion of the shale with air in a zone fractured by the simultaneous detnotation of 21 tons (19,100 kg) of chemical explosive divided between 2 wells drilled 60 feet apart.

TITLE:

Interactions Between Ground Water and In Situ Reported Oil Shale

AUTHOR:

Parker, H.W., R.M. Bethea, N. Guven, M.N. Gazdar, and J.C. Watts

ADDRESS:

Tex Tech University, Lubbock

REFERENCE:

AIChE, New York, NY, 1977 Vol. 1

SUMMARY:

In the reported experiments, leaching rate studies lasting up to 30 days have been conducted on 3.65 cm diameter retorted oil shale cores. Leaching continued at noticable rates even after this prolonged time. Slow chemical reactions between the high pH leachate and minerals in the spent oil shale continue to generate new soluble ions such as K and Li for leaching from the spent oil shale. 10 refs.

TITLE:

Environmental Effects of In Situ Recovery of Shale Oil

AUTHOR:

R.E. Poulson and H.B. Jenson

ADDRESS:

Laramie Energy Research Center, Research and Development Administration
Laramie WI   82071

REFERENCE:

Proceedings of workshop in "In Situ Recovery Techniques of Oil from Oil Shale" NSF/RANN Report No. 75-001

SUMMARY:

This paper discusses the potential effects of in situ shale-oil recovery on environmental concerns relative to those that have been published for aboveground recovery. The salient environmental features of the in situ approach are discussed with respect to air, land, water, and socioeconomic elements. Applicability of in situ techniques is shown to be quite site specific. Where applicable in situ recovery could minimize mining activity, particulate emissions, water supply requirements, and land requirements. Gaseous emissions could be a similar problem in either in situ or aboveground processing on a large scale. The need for managing large volumes of water can occur in either approach. Internal-combustion in situ retorting may produce in itself large volumes of organic- and mineral-laden water for recovery or disposal. Similar numbers of people would probably be employed in either approach. Not enough is known about in situ methods or details of the resource in its matrix to make realistic cost estimates of general applicability.

TITLE:

Minor Elements in Oil Shale and Oil-Shale Products

AUTHOR:

R.E. Poulson, J.W. Smith, N.B. Young, W.A. Robb, and T.J. Spedding

ADDRESS:

Laramie Energy Research Center, Energy Research and Development Administration, Laramie, Wymoing 82071

REFERENCE:

(Presented at the BNS/EPA Workshop on Standard Reference Materials for Oil-Shale Environmental Concerns,
Gaithersburg, MD, D.A. Becker, ed., November 1975, to appear in proceedings.)

SUMMARY:

Order of magnitude minor elemental analyses for several Green River Formation oil shales, shale oils, and retort waters were presented. The oil-shale analyses showed a remarkable uniformity between Colorado Piceane Creek Basin Mahogany zone and saline zone oil shales. Comparison with earlier data of other workers extends this uniformity to rich and lean Mahogany zone oil shales, to the Mahogany and R-4 zones of the Piceane Creek (Colorado) and Uinta (Utah) Basins.

Crude shale oils and retort waters were shown to have variations in trace elements of up to 10^4 even in products from very similar retorting runs. The cause of such variations could not be determined from the data. Possible oil shale, subtle differences in retorting processes, or special external influences, on the products after retorting.

TITLE:

Characteristics of Synthetic Crude from Crude Shale Oil Produced by In Situ Combustion Retorting

AUTHOR:

R.E. Poulson, C.M. Frost, and H.B. Jensen

ADDRESS:

U.S. Energy Research and Development Administration,
Laramie Energy Research Center
Laramie, Wyoming 82071

REFERENCE:

Advances in Chemistry Series, Number 151, Shale Oil, Tar Sands, and Related Fuel Sources

SUMMARY:

The nitrogen contents of in situ crude shale oils may be somewhat lower than those of crude shale oils produced in other retorts; however, these in situ oils still contain more than twice as much nitrogen as high nitrogen petroleum crude oils. Because existing refineries would not be able to cope with the high nitrogen content of shale oil if it were a substantial portion of the refinery feed, the National Petroleum Council (NPC) has suggested that crude shale oil be upgraded at the retorting site by a catalytic hydrogenation process to produce a synthetic, premium feedstock called "syncrude." The production of such a syncrude from in situ crude shale, a description of its bulk properties, and a comparison of its properties to those of an NPC-type syncrude have been covered in Chapter 6 of this volume. This paper reports the compound-type characteristics of that syncrude produced by Frost by catalytic hydrogenation of in situ crude oil. Special attention has been devoted to the nitrogen-compound types that are likely to be present in a syncrude because it is these compounds with which a refiner will have to deal if he uses this or a similar syncrude as his refinery feed.

In addition to reporting the nitrogen-compound types present in this syncrude, this paper also reports on the nitrogen types in intermediate hydrogenation products in order to relate this study to other studies which have shown that the efficency of nitrogen removal depends upon the nitrogen types in the charge stock.

TITLE:

Hydrocarbon Fuels from Oil Shale

AUTHOR:

F.C. Schora, P.B. Tarman, H.L. Feldkirchner, and S.A. Weil

ADDRESS:

Institute of Gas Technology, Chicago, IL

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering Conference Proceedings
1976 Vol. I.

SUMMARY:

A new process for producing substitute natural gas and/or middle-distillate-type oils from oil shale is described. This process employs controlled, countercurrent heating of the shale in the presence of hydrogen at moderate pressure levels. Controlled heating in hydrogen promotes almost complete recovery of the kerogen (Organic carbon) compared with about 75% recovery by conventional retorting.

The range of operating conditions for optimum organic carbon recovery was determined in laboratory thermobalance tests. Organic carbon recoveries as high as 98% were obtained from oil shale over a wide range of organic carbon content. High recoveries were also obtained for a wide range of shale particle sizes.

Flow tests were made in a 10-cm (4-inch) diameter reactor to evaluate the process in continuous countercurrent operation. Organic carbon recoveries as high as 95% were obtained at shale flow rates of up to 57 kg/hr (125 lb/hr). Temperature was the most significant operating variable found in the range of shale space velocities studied.

Our current work involves operating a large process development unit to obtain results under conditions approaching adiabatic. Laboratory thermobalance tests are also being conducted to evaluate the process concept with Eastern oil shales.

TECHNICAL REPORTS:
COAL-FIRED POWER PLANTS

TITLE:

Research and Development Relating to Lignite Use in Power Production

AUTHOR:

Everett A. Soundreal, Gordon H. Gronhord, Wayne R. Kube

ADDRESS:

Grand Forks Energy Research Center, ERDA
Grand Forks, ND 58202

SUMMARY:

The present emphasis on coal utilization in the United States together with the requirements for reduction of sulfur dioxide emissions has dramatically increased utilization of lignite and subbituminous coals to over 80 million tons annually, mostly for electrical power generation. Boiler and fuel specifications are summarized for three new facilities from 400 to 500 MW designed to use high fouling lignites from Texas and North Dakota. Ash fouling of fire-side boiler tubes is the most serious operating problem. Designs are conservative with low furnace heat release rates, relatively wide tube spacing, and soot blowers. Research in ash fouling is described and the role of sodium as an indicator of fouling discussed. Particulate emissions from boilers fired with low-rank coals are being controlled using electrostatic precipitators and wet scrubbers. Design data are presented and research activities reviewed. High moisture and high sodium contents result in satisfactory performance for ESPs operating on North Dakota Lignite. Although lignites are considered low in sulfur, most lignite-fired boilers will require some SO_2 removal to meet emission standards. Research work on use of the natural alkali in lignite fly ash in wet scrubbers is discussed. Included are data on operating and planned ash-alkali scrubbers. Emission standards are reviewed.

TITLE:

Geochemical Controls on Trace Element Concentrations in Natural Waters of a Proposed Coal Ash Landfill Site

AUTHOR:

Donald O. Whitmore and John Switek

ADDRESS:

Kansas State University

SUMMARY:

The Kansas Power and Light Company is building a coal-fueled electric energy center in an area consisting of 12,800 acres and located a few miles north of Belvue in Pottawatomie County, Kansas. The four units planned for the center will have a total generating capacity of approximately 2800 megawatts and burn 8 million tons of low sulfur Wyoming coal a year. The first unit is to be in service by January, 1978. The total site area will include the main plant and cooling tower structures, a large and a small cooling tower makeup reservoir, coal handling and storage areas, and two ash storage landfills. The ash landfills will involve the transport of coal bottom ash and fly ash to separate impoundments in a small valley southwest of the power plant by hydraulic slucing utilizing recycled process water. Drainage from the main coal storage area, the demineralizer system, and all buildings will be collected in the ash impoundments.

The possible effects on natural water quality could come from three main sources: (1) gases and particulates released to the atmosphere from the power plant chimneys, which could affect the chemistry of the protein precipitation, surface water, and soil moisture; (2) seepage from the ash storage impoundments and recharge into ground-water aquifers; (3) process waters released from the ash impoundment into a small stream. Besides the possible effects of sulfur and nitrogen oxides on air and water quality, trace elements might be a potential problem in the immediate vicinity of the power plant.

Before the future effects of the power plant can be determined, however, the present controls on the natural water quality must be understood. Therefore, the objectives of this study were to determine the geochemical controls on certain trace elements in the natural waters of the proposed ash storage landfill site before the plant became operational. The trace elements selected (Cr, Cu, Hg, Pb, As, Se, Cd, and Zn) are all toxic in excessive amounts to plants, animals, or man.

Coal-Fired Power Plants

TITLE:

Clean Coal Combustion through Coal Washing and Blending

AUTHOR:

James K. Shou[1], O.J. Hahn, H.C. Kao and T.C. Wu[2]

ADDRESS:

[1]Institute for Mining and Minerals Research

[2]Mechanical Engineering Department, University of Kentucky, Lexington, Kentucky.

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering Conference Proceedings, 1, 300 (1976).

SUMMARY:

Blending of a high sulfur coal with a low sulfur coal could be one of the immediate means of complying with suflur dioxide emission regulations. Laboratory and boiler tests have been completed for high sulfur, high ash Western Kentucky seam coal. Blending of these coals at the ratio of 1/4, 1/2, and 3/4 and their combustion characteristics have been analyzed. Bench scale studies are conducted to determine the extent to which the ash and sulfur content of western Kentucky coals could be reduced by float-sink method. Although no significant combustion characteristic difference is observed between input Kentucky coals, their ash compositions are quite different. Coal cleaning by heavy media washing is still a viable method of sulfur and ash reduction for coals that contain a relatively high percentage pyritic sulfur.

TITLE:

AMMONIA INJECTION: A Route to Clean Stacks

AUTHOR:

C.C. Shale

ADDRESS:

Morgantown Energy Research Center, Bureau of Mines, U.S. Department of Interior, P.O. Box 880, Morgantown, WV 26505

REFERENCE:

Advances in Chemistry 141, 195, 1973

SUMMARY:

Previously reported results of laboratory research have demonstrated essentially complete removal of sulfur dioxide from mixed gases by ammonia injection; the simulated stack gas contained 4200 ppm of the contaminant which is equivalent to combustion of coal containing 6.0% sulfur. Continuation of this work using gases from a small coal-fired combustor confirms earlier findings for removal of sulfur dioxide to less that 100 ppm and shows that ammonia can be regenerated on a continuous basis for re-use with minimal loss. Product sulfur-bearing salts and remaining ash are removed effectively from the gas in a wet scrubber, apparently assisted by the process of nucleation. The ammonia-injection process could provide effective control of sulfur dioxide from coal-burning power plants.

TITLE:

Fluidized Combustion of North Dakota Lignite

AUTHOR:

Gerald M. Goblirsch and Everett A. Sondreal

ADDRESS:

Grand Forks Energy Research Center
Grand Forks, N.D.

REFERENCE:

Technology and Use of Lignite Symposium
Grand Forks, N.D., May 1977 (GFERC/IC-77/1) Page 82

ABSTRACT:

Evaluation of the sulfur retention of high alkaline coal on fluidized-bed combustion was studied. Data are presented on the effects of temperature, fuel and air ratios, superficial gas velocity and coal particle size.

TITLE:

Desulfurization of Coals by High-Intensity High-Gradient Magnetic Separation: Conceptual Process Design and Cost Estimation

AUTHOR:

C.J. Lin and Y.A. Liu

ADDRESS:

Department of Chemical Engineering, Auburn University, Auburn, Ala. 39830

REFERENCE:

Am. Chem. Soc., Div. of Fuel Chem. Preprints 22 (2), 113 (1977).

SUMMARY:

High-intensity high-gradient magentic separation (HGMS) has become a viable method for the removal of pyritic sulfur from coal prior to burning. A short review of recent work on this subject appearing in the literature is given and the process design and economics for both coal/water slurries and liquefied coal is discussed.

TITLE:

Trace-Element Emissions from Western U.S. Coal-Fired Plants

AUTHOR:

R.C. Ragaini and J.M. Ondov

ADDRESS:

Lawrence Livermore Laboratory, Unviersity of California
Livermore, California 94550

REFERENCE:

Preprint UCRL-77669 Rev. 1

SUMMARY:

The Lawrence Livermore Laboratory program to evaluate the trace elements in stack emissions from coal-fired power plants is described. Stack sampling and analysis of fly ash at modern western U.S. power plants is discussed. Scanning-element-microscope techniques are shown to be essential for accurate sizing of stack particles sampled with cascade impactors. Particle-size distributions for volatile and nonvolatile trace elements are reported. Comparisons show that the trace element enrichment factors of western and eastern U.S. coal-fired power plants are significantly different.

TITLE:

The Behavior of the Natual Radionulides in Wester Coal-Fired Power Plants

AUTHOR:

David G. Coles, Richard C. Ragaini, and John M. Ondov

ADDRESS:

Lawrence Livermore Laboratory, University of California
Livermore, California 94550

REFERENCE:

Preprint UCRL-78940

SUMMARY:

The behavior of the gamma-emitting radionuclides from the natural decay series (^{232}TH, ^{235}U, and ^{238}U as well as ^{40}K) in coal-fired power plants is described. Lead-210 was enriched in the finer stack fly-ash particles. Thorium nuclides and ^{40}K showed little fractionation in the fly ash and bottom ash (slag or klinkers) compared to the original coal. Uranium-238 and ^{235}U showed a definite enrichment in the finer stack fly-ash particles. An explanation for this relationship includes a bimodal residence for uranium in the coal.

TITLE:

Elemental Emissions from a Western Coal-Fired Power Plant: Preliminary Report on Current Plume and In-Stack Sampling

AUTHOR:

J.M. Ondor, R.C. Ragaini, A.H. Biermann, C.E. Choquette, G.E. Gordon and W.H. Zoller

ADDRESS:

Lawrence Livermore Laboratory
Livermore, California

REFERENCE:

Preprint UCRL 78825

SUMMARY:

In recent years, coal has become increasingly important for the production of electric power in the U.S. Because of the potential biomedical and environmental hazards associated with release of potentially toxic substances during coal combustion, several authors have sought to characterize particulate emissions from coal-fired power plants. Results of these studies indicate that elemental concentrations become enriched inversely with particle diameter through a vaporization-surface condensation mechanism and through preferential penetration of smaller particles through a vaporization-surface condensation mechanism and through preferential penetration of smaller particles through emission-control devices. In addition, consideration of mass balance indicates that emission of several species (including Hg, As, Se, Br, I) have a significant vapor-phase component as stack temperatures.

TITLE:

Interlaboratory Comparison of Neutron Activation and Atomic Absorption Analyses of size-Classified Stack Fly Ash

AUTHOR:

J.M. Ondov, R.C. Ragaini, R.E. Heft, G.L. Fisher, D. Silberman, B.A. Prentice

ADDRESS:

Lawrence Liver Laboratory
University of California
Livermore, California 94550

REFERENCE:

Preprint UCRL 78194

SUMMARY:

We have undertaken a collaborative study to quantitate the chemical composition of fly ash collected in-stack at a major coal-fired power plant. This study is part of an effort to assess the potential biomedical health hazards associated with coal combustion for electric power generation.

The power plant burns low sulfur (0.5%), high ash (23%) coal and is equipped with an electrostatic precipitator (95% efficiency) emission control system. The fly ash was fractionated in situ at the time of collection with a specially designed aerodynamic sizing into four fractions: <3 μm, 3-8 μm 8-15 μm, and >15 μm. These fractions were mixed to ensure homogeneity and were analyzed for 18 elements by atomic absorption spectroscopy (AAS) at the U.C. Davis Laboratory and for 34 elements by Instrumental Neutron Activation analysis (INAA) at the Lawrence Livermore Laboratory (LLL).

The procedure for flame and flameless AAS involved a HF-H_3BO_3 sample dissolution procedure with steps to control flame ionization, molecular absorption, and interference from Na, K, and Fe,. The INAA procedure involved two neutron irradiations at the Livermore Pool-Type Reactor, each followed by three Ge(Li) detector counts of the gamma-emitting radionuclides. The gamma-ray spectra were analyzed using GAMANAL, a LLL peak-analysis code.

Comparison of analyses of NBS fly ash SRM 1633 by both AAS and INAA indicated excellent agreement with the NBS-certified elements and with other previously published values. Comparative analyses of the four size-classified elements and with other previously published values. Comparative analyses of the four size-classified fractions are presented. Precision and accuracy are also compared for elements analyzed by both techniques.

TITLE:

Supportive Studies of Pressurized Fluidized-Bed Combustion

AUTHOR:

Argonne National Laboratory

ADDRESS:

Argonne, IL

REF:

Coal Power and Combustion (Jan-Mar 1977)
DOE/ET-0025/1
UC-90E

SUMMARY:

Argonne National Laboratory (ANL), under ERDA sponsorship since November 1974, is conducting a research and development program to evaluate the feasibility and potential of fluidized-bed combustion at pressures of up to ten atmospheres. The objectives are:

Optimize combustion procedures while maximizing retention of sulfur dioxide in the fluidized bed, minimizing the amount of nitrogen oxides in effluent gas, and increasing combustion efficiency.

Evaluate the behavior and efficiency of the system for different types of coal such as lignite and subbituminous.

Study the levels of trace-element pollutants in the flue gas and the effects of process operating conditions on these levels.

Determine the mechanisms of the various reactions in the process and how their thermodynamices and kinetics are affected when parameters are varied.

TITLE:

Pressurized Fluidized - Bed Component Test and Integration Unit (PFB/CTIU)

AUTHOR:

Argonne National Laboratory

ADDRESS:

Argonne, IL

REF:

Coal Power and Combustion (Jan-Mar 1977)
DOE/ET-0025-/1
UC-90E

SUMMARY:

A conceptual design of a three-Mw Component Test and Integration Unit was completed by Argonne National Laboratory. The unit is intended to support the pressurized fluidized-bed (PFB) combustor development program by providing the flexibility to investigate alternative and advanced concepts of fluidized-bed combustion. It will allow testing of components, instrumentation, and materials on a scale that is large enough to utilize commercial-scale equipment yet small enough to allow rapid modification of equipment and operating conditions.

TITLE:

Modification of Ash Behavior in Lignite Fired Boilers

AUTHOR:

B.K. Baker and W.H. Gardiner

ADDRESS:

Saskatchewan Power Corporation
Regina, Saskatchewan, Canada

REFERENCE:

Technology and Use of Lignite Symposium
Grand Forks, N.S. May 1977 (GFERC/IC-77/1) page 74

SUMMARY:

Experiences of the Saskatchewan Power Corporation in burning lignite are reviewed which are used for the design of a new mine and power plant. Also discussed are methods of minimizing slagging and fouling conditions in pulverized-lignite-fired boilers with beneficial effects of calcium additives on ash fusion temperature.

TITLE:

The Energy Future and the Chemical Fuels

AUTHOR:

J. O'M. Bockris

ADDRESS:

Institute of Solar and Electrochemical Energy Conversion,
Flinders University, Adelaide, Australia

REFERENCE:

Pure & Applied Chemistry 47, 25, 1976

SUMMARY:

An account is first given of the origin of present chemical fuels, with particular reference to the lastingness of coal. Methods of estimation of these fuels are discussed and the greenhouse effect arising from the burning of coal is described. Consideration is then given to methods available for extending the uses of chemical fuels, including interfacing them with new inexhaustible, clean energy sources. Finally, accounts are given of the Hydrogen Economy and of the production of chemical fuels from wind energy in massive wind belts.

TITLE:

Trace Element Mass Balance Around a Coal-Fired Steam Plant

AUTHOR:

N.E. Bolton, J.A. Carter, J.F. Emery, C. Feldman, W. Fulkerson, L.D. Hulett
and W.S. Lyon

ADDRESS:

Oak Ridge National Laboratory, P.O. Box 4, Oak Ridge, Tennessee 37830

REFERENCE:

Advances in Chemistry Series 141, 175, 1975.

SUMMARY:

Mass balance measurements for 41 elements have been made around the Thomas A. Allen Steam Plant in Memphis, Tennessee. For one of the three independent cyclone boilers at the plant, the concentration and flow rates of each element were determined for coal, slag tank effluent, fly ash in the precipitator inlet and outlet (collected isokinetically). Measurements by neutron activation analysis, spark source mass spectroscopy (with isotope dilution for some elements), and atomic adsorption spectroscopy yielded an approximate balance (closure to within 30% or less) for many elements. Exceptions were those elements such as mercury, which form volatile compounds. For most elements in the fly ash, the newly installed electrostatic precipitator was extremely efficient.

TITLE:

Evaluation of a Pressurized Fluidized-Bed Combustion (PFBC) Combined Cycle Power Plant Conceptual Design

AUTHOR:

Burns and Roe Industrial Services

ADDRESS:

Paramus, NJ

REF:

Coal Power and Combustion (Jan-Mar 1977)
DOE/ET-0025-/1
UC-90E

SUMMARY:

Under the terms of this contract, Burns and Roe Industrial Service will provide an evaluation of a coal-fired combined-cycle power plant conceptual design. The design will use a pressurized fluidized-bed (PFB) combustor air heater cycle with a unique supplmental fuel-fire atmospheric fluidized-bed (AFB) heat recovery boiler for obtaining high efficiency. Improvement in the cycle will be achieved by reheating the gas turbine effluent in the PFB or by additional heating of the gas turbine effluent in the AFB.

TITLE:

Rejection of Trace Metals from Coal During Beneficiation by Agglomeration

AUTHOR:

C. Edward Capes, Allan E. McIlhinney, Douglas S. Russell, and Aurelio F. Sirianni

ADDRESS:

Division of Chemistry, National Research Council of Canada, Ottawa, Canada

REFERENCE:

Environmental Science and Technology, Vol 8, Number 1, 35 (1974)

SUMMARY:

Examined was the rejection of trace quantities of heavy metals from coals during the process of fine grinding followed by selective oil agglomeration of the carbonaceous constituents. Six different steam and coking coals, mainly from Canadian and U.S. sources, were treated. The level of most heavy elements was generally low but, in light of the large throughputs of power plants, the potential environmental hazard may be significant, especially for those elements which are volatile or may form volatile compounds when fired. Many of the trace metals were substantially removed during agglomerative beneficiation of the coal. Some metals that are apparently in organic association in the coal remained in the agglomerated product. In addition to the reduced environmental hazard a number of other advantages in upgrading coals prior to use are discussed.

TITLE:

Industrial Application of Fluidized-Bed Combustion Processes

REF:

Coal Power and Combustion (Jan-Mar 1977)
DOE/ET-0025/1
UC-90E

SUMMARY:

During the past decade, the federal government has evaluated direct combustion of coal by the fluidized-bed combustion process. As a result of these evaluations, it has been determined that the fluidized-bed combustion process can efficiently convert coal to usable power in an environmentally acceptable manner. In order to develop the fluidized-bed combustion concept for demonstration in the industrial sector, ERDA issued Program Opportunity Notice (PON) FE-1, a part of the National Energy Research, Development and Demonstration Program. Four categories of applications were identified and defined.

Category I--An industrial steam generator capable of producing steam of the quality and quantity for back pressure turbines, industrial processes, and heating requirements.

Category II--An industrial boiler with the capability of producing steam of the quality and quantity suitable for process heating and space requirements of industrial or institutional facilities.

Category III--An indirect-fired heater, utilizing tubes or other heat exchange devices, designed to heat process liquids or gases.

Category IV--A direct-fired heater capable of heating process materials by direct contact between the combustion gases and the process materials.

In each of the PON contracts, the program objectives as stated in the PON are:

Identify and conduct evaluations of industrial boiler or process heater requirements to determine the application in which fluidized-bed combustion is technically, economically, and environmentally feasible.

Design, construct, operate, test, and demonstrate prototype boilers or heaters to burn coal and other fuels in an environmentally-acceptable manner.

Obtain sufficient data from prototype operations to design and construct a commercial-size unit.

TITLE:

Energy Conversion Alternatives Study (ECAS)

AUTHOR:

Lewis Research Center, National Aeronautics and Spcace Administration

ADDRESS:

Cleveland, OH

REF:

Coal Power and Combustion (Jan-Mar 1977)
DOE/ET -0025/1
UC-90E

SUMMARY:

The overall objective of this project, started in August 1974, is to study advanced power generation techniques which can use coal or coal-derived fuels and to evaluate their relative merits and potential benefits. ECAS is to be conducted using a common basis of technology and materials performance in the light of new national goals and current conditions. In addition, ECAS is to define development plans for the various advanced systems providing estimates of both cost and risk, and is to provide a basis for establishing needed technology or development programs. The evaluation of alternative systems on a comparable basis is needed so that cost-benefit analyses may be performed and the preferred systems selected for further development.

TITLE:

Coal-Oil Slurry Combustion Program

AUTHOR:

Pittsburgh Energy Research Center

ADDRESS:

Pittsburgh, PA

REF:

Coal Power and Combustion (Jan-Mar 1977)

SUMMARY:

A coal-oil slurry combustion project is being conducted by the Pittsburgh Energy Research Center (PERC) to provide ERDA with an in-house technical capability in support of its coal-oil slurry combustion program. The purpose is to investigate and validate the potential of this near-term retrofit technology for oil conservation and increased coal utilization. PERC is presently operating a 100 Hp firetube oil-fired boiler on coal-oil slurry and is designing and constructing a liquid-fuel-fired Combustion Test Facility (CTF) analogous to the one currently operated by the Energy Conversion Group for solid fuel research. The CTF should provide the data required to design combustion systems using various slurries under process development for both industrial and utility boilers.

TITLE:

Solvent-Refined Coal (SRC) Combustion Test Program

AUTHOR:

Pittsburgh Energy Research Center

ADDRESS:

Pittsburgh, PA

REF:

Coal Power and Combustion (Jan-Mar 1977)
DOE/ET-0025/1
UC-90E

SUMMARY:

As part of the overall ERDA program to increase coal utilization, combustion tests on Solvent-Refined Coal (SRC) are being conducted by the Pittsburgh Energy Research Center (PERC). SRC is a low-ash, low-sulfur, coal-derived fuel having a melting point of less than 300°F and a heating value of approximately 16,000 BTU per pound. Although the process of solvent refining is fairly well defined, there has as yet been no effective evaluation of SRC as a utility boiler fuel. The specific purpose of this project, therefore, is to study the handling, pulverizing, combustion, and fouling characteristics of SRC.

TITLE:

R & D Planning Assistance Services

REFERENCE:

Coal Power and Combustion, Quarterly Report from the Office of Fossil Energy, April-June 1976, Energy Research and Development Administration, 20 Massachusetts Avenue N.W., Washington D.C. 20545

SUMMARY:

R & D planning assistance services are being provided by the MITRE Corporation under the sponsorship of ERDA. Under this contract, initiated in December 1974, MITRE is to provide technical and other assistance in the preparation and implementation of national program plans and analyses for R & D in coal-based advanced power and direct combustion systems. Advanced power systems research is directed toward development of power conversion systems that will permit efficient and economically competitive generation of electric power using coal and coal-derived fuels. The advanced power systems being considered in this program include open-cycle gas turbines (especially in combined-cycle configuration), closed-cycle turbines, and alkali metal vapor turbines. Fluidized-bed combustion research including atmospheric (utility, industrial, retrofit) and pressurized (utility, industrial) systems, seeks to develop commercial systems for efficient burning of coal in an environmentally acceptable manner.

TITLE:

Anthracite Refuse Utilization

AUTHOR:

Morgantown Energy Research Center

ADDRESS:

Morgantown, WV

REF:

Coal Power and Combustion (Jan-Mar 1977)
DOE/ET-0025/1
UC-90E

SUMMARY:

Anthracite refuse and silt bank materials which have resulted from the mining and cleaning of anthracite coal in the northeaster section of Pennsylvania are potential sources of low-carbon, high-ash fuel. The mining region in which the material is located covers only about 480 square miles and is farily densely populated. The U.S. Bureau of Mines has estimated that within the area there are 800 banks containing a total of 910 million cubic yards of refuse. This material has been deposited by mining operations and reject streams from preparation and cleaning plants over the entire history of the region. The deepest layers of material were deposited over 100 years ago when preparation methods were crude, whereas the surface layers have resulted from much better washing procedures and are therefore essentially depleted of coal. Some of the older banks have been reworked in recent years using better cleaning methods to recover the coal and consequently the characteristics of the refuse varies widely from bank to bank and even within a single bank.

TITLE:

Application of Fluidized-Bed Combustion Technology to Industrial Boiler

AUTHOR:

Exxon Research and Engineering Company

ADDRESS:

Linden, NJ

REF:

Coal Power and Combustion (Jan-Mar 1977)
DOE/ET-0025/1
UC-90E

SUMMARY:

Several coal conversion technologies, including direct combustion of coal in a fluidized-bed boiler, coal liquefaction, and coal gasification, are currently being developed. When implemented on a commercial scale, these technologies will greatly increase the utility of coal as a highly acceptable source of industrial energy. Of these technologies, fluidized-bed combustion offers the greatest possiblity of near-term implementation. Therefore, Exxon Research and Engineering Company is conducting a research program to study the diverse industrial applications of fluidized-bed combustion technology.

TITLE:

High Temperature Turbine Technology (HTTT) Program

REF:

Coal Power and Combustion (Jan-Mar 1977)
DOE/ET-0025/1
UC-90E

SUMMARY:

Present base load electric generating plants, which can consume coal directly in combination with conventional steam turbine systems, achieve efficiencies of between 35 and 38 percent depending upon the fuel sulfur content and energy required for stack gas scrubbing. Therefore, if clean, coal-derived fuels are to be used for baseload power generation at hundreds of megawatts power level, energy conversion systems of higher efficiency or lower overall cost must be developed to compensate for the process energy losses, and possible other additional costs, incurred in coal gasification or liquefaction.

TITLE:

Fluidized-Bed Waste Material Utilization

REF:

Coal Power and Combustion (Jan-Mar 1977)
DOE/ET-0025/1
UC-90E

SUMMARY:

When coal, containing three percent sulfur and 12 percent ash, is burned in fluidized-bed boilers along with a quantity of limestone sufficient to maintain a molar ration between 2:1 and 3:1 of calcium to sulfur, between 400 to 600 pounds of waste bed material is generated for each ton of coal burned. About 50 percent of this waste material is drawn from the fluidized bed, the rest being discharged as fly ash. The material drawn from the bed usually consists of 25 to 35 percent unhydrated lime, 50 to 60 percent calcium sulfate, and varying amounts of silica, aluminum, iron, and magnesium oxides. ERDA has funded various studies to demonstrate the effectiveness of using this fluidized-bed combustion (FBC) waste for agricultural purposes, and for non-agricultural utilizations.

TITLE:

Pressurized Fluidized-Bed Combustor and Turbine Power Generation

AUTHOR:

Combustion Power Company, Inc.

ADDRESS:

Menlo Park, CA

REF:

Coal Power and Combustion (Jan-Mar 1977)
DOE/ET - 0025/1
UC-90E

SUMMARY:

A combustor-gas turbine system is being developed by Combustion Power Company, Inc. (CPC), under the auspices of ERDA. This contract is an extension of an earlier research and development contract between CPC and the Environmental Protection Agency (EPA) in which municipal solid waste was burned with minimal pollution in CPC's CPU-400 pressurized fluidized-bed combustion and gas turbine system. The program objective is to develop a process to generate electrical energy through the combustion of high-sulfur coals mixed with dolomite, using an on-line gas turbine for direct power generation.

TITLE:

High Temperature Dust Control

AUTHOR:

Construction Engineering Research Laboratory
U.S. Department of the Army

ADDRESS:

Champaign, IL

REF:

Coal Power and Combustion (Jan-Mar 1977)
DOE/ET-0025/1
UC-90E

SUMMARY:

Under the sponsorship of ERDA, the Construction Engineering Research Laboratory (CERL), U.S. Department of the Army, is evaluating the efficiency of a patented Particle Precipitating Heat-Transfer Surface (PPHTS) device in removing dust particles from the high-temperature exhaust gas streams of fluidized-bed combustors. The fluidized-bed combustor used in the projects is operated for ERDA by Pope, Evans and Robbins, Inc. (PER) at a government-owned test facility in Alexandria, Virginia.

TITLE:

Mercury Distribution in Soil Around a Large Coal-Fired Power Plant.

AUTHOR:

Alan B. Crockett and Robert R. Kinnison

ADDRESS:

Monitoring Systems Research and Development Division
Environmental Monitoring and Support Laboratory
Las Vegas, Nevada 89114

REFERENCE:

EPA-600/3-77-063

SUMMARY:

Detailed soil sampling and analyses for mercury residues indicate no significant differences in mercury residue levels within 30 km of a large coal-fired power plant. Other recent data indicate emissions of 589 and 1,372 kg of mercury by a coal-fired power plant and a smelter, respectively, and pose no health hazard relative to air comtamination (Horn, 1975). These data should be considered in making decisions concerning regulation of mercury emissions from coal-fired power plants. Horn (1975) indicates that U.S. coal-fired utilities emit 9 percent of all human-related releases to the atmosphere in the U.S. In 1974, utility emissions amounted to only 4 percent of the natural degassing mercury loss in conterminous United States (calculated from Horn, 1975).

TITLE:

Combined-Cycle Electric Power Generation Using Pressurized Fluidized-Bed Combustion

AUTHOR:

Curtiss-Wright Corporation

ADDRESS:

Wood-Ridge, NJ

REF:

Coal Power and Combustion (Jan-Mar 1977)
DOE/ET-0025/1
UC-90E

SUMMARY:

Curtiss-Wright Corporation, under the sponsorship of ERDA, is conducting a program to design, construct, operate, and evaluate a coal-fired combined-cycle pilot pressurized fluidized-bed (PFB) technology and high-sulfur coals. The program was inititated on March 1, 1976. The pilot plant program is a five-year, four-phase effort. Phase I is a 14-month program to provide:

Conceptual design of a commercial coal-fired 300-500 Mw combined-cycle generating station using the PFB combustion technique.

Pilot plant design which is representative of the commerical concept.

Pilot plant site and environmental assessment study.

Technology support programs which provide data on the performance of the selected PFB design.

Phase II is an eight-month effort to complete the detail design drawings and specifications of the pilot plant, prepare a construction bid package, and obtain bids for evaluation. Phase III is a 20-month construction period for the manufacturing, build-up, and installation of the pilot plant. The final phase is a 24-month effort to operate the pilot plant and to evaluate operating parameters and durability using several coal types. At the conclusion of this phase, a reassessment of the commercial plant conceptual design will be conducted.

TITLE:

Magnetohydrodynamic Power Generation

AUTHOR:

ERDA

ADDRESS:

Pittsburgh Energy Research Center
4800 Forbes Avenue
Pittsburgh, PA. 15213

REF:

Clean Energy from Coal (p. 17)

SUMMARY:

A promising technique for improving the efficiency in converting fossil fuels into electrical energy involves the principles of magnetothydrodynamics (MHD). In an MHD power plant, electricity is generated by passing very high-temperature, electrically conductive combustion gases through a magentic field. The gases leaving this MHD generator are still hot enough to produce additional electricity in a conventional steam power plant. The efficiency of a commercial combined MHD/steam turbine plant would be 25 to 50 percent greater than that of modern coal-fired stations. Research conducted at the Pittsburgh Energy Research Center has also shown that MHD power plants will operate with extremely low levels of pollutant emissions. Low-grade, high-sulfur coals can thus be utilized in an environmentally desirable manner.

TITLE:

Fate of Trace Mercury in the Combustion of Coal

AUTHOR:

R.C. Diehl, E.A. Hattman, H.Schultz, and R.J. Haren

ADDRESS:

Pittsburgh Energy Research Center, Pittsburgh, PA

REFERENCE:

Bureau of Mines Managing coal Wastes and Pollution Program, Technical Progress Report - 54, May 1972.

SUMMARY:

Coal, fly ash, and blue gas samples were analyzed for mercury (Hg) by double gold amalgamation-flameless atomic absorption spectrophotometry. The purpose of the study was to elucidate the fate of the trace mercury in the coal when the coal is burned. Samples were collected from a bench-scale 100-g/hr combustor, a 500-lb/hr combustor, and three coal-burning powerplants. In all cases mercury was found in the fly ash. The amounts ranged from about 9 to about 70 percent of the mercury in the coal that was burned.

TITLE:

Coal Combustion

AUTHOR:

ERDA

ADDRESS:

Pittsburgh Energy Research Center
4800 Forbes Avenue
Pittsburgh, PA 15213

REF:

Clean Energy from Coal (p. 14-15)
PERC 1000

SUMMARY:

The PERC research and development program in coal combustion has as its primary near-term objective the development of equipment and procedures for efficient and clean burning of coal-oil slurries to raise steam for use as such or for electric power generation. Also of major interest is the development of techniques for burning coal-derived fuels such as chars and solvent refined coal (SRC) in conventional power plants. Combustion of various agricultural wastes is also being studied. The goals of these project are to obtain more efficient combustion and to determine the combustion characteristics and air pollution aspects for the various fuels studied.

TITLE:

Coal-Like Substances from Low-Temperature Pyrolysis at Very Long Reaction Times

AUTHOR:

R.A. Friedel, J.A. Queiser, and H.L. Retcofsky

ADDRESS:

U.S. Department of the Interior, Bureau of Mines, Pittsburgh Coal Research
Center, Pittsburgh, Pennsylvania 15213

REFERENCE:

Journal of Physical Chem., 74, 908 (1970).

SUMMARY:

The importance of long reaction times in the coalification process has been demonstrated in the laboratory. Samples of cellulose and pine sawdust in evacuated, sealed glass vials have been heated at 200° for 2 years. Black coal-like chars were produced; conventional heating at 200° for hours produces very little chemical change. The chars were characterized by infrared and electron spin resonance spectra and by ultimate analysis. The infrared spectra of the pine sawdust char and of a subbituminous coal are nearly identical, except for differing carbonyl absorption. The spectrum of the cellulose char is also similar to that of the subbituminous coal. The electron spin resonance (esr) results show that g values, line widths, and spin concentrations are very similar for the two chars, and resemble closely the corresponding values for subbituminous coal. 200° is considered a reasonable coalification temperature; a feasible depth of burial can provide such temperatures. The experimental coalification obtained in only 2 years supports the hypothesis that geologic time could produce all ranks of coals, from lignite to anthracite, at temperatures below 200°.

TITLE:

Coal-Fired Combined-Cycle Development Program

AUTHOR:

General Electric Energy Systems - Technology Division

ADDRESS:

Schenectady, NY

REF:

Coal Power and Combustion (Jan-Mar 1977)
DOE/ET-0025/1
UC-90E

SUMMARY:

The Energy Systems Program Department (ESPD) of General Electric leads the program, performing the required program management, system engineering, reliability, and environmental effort. Foster-Wheeler, under subcontract to GE, is responsible for the combustor/steam generator design activity and technology support. Exxon is supplying experimental support, using their miniplant facility and integrating the testing with ongoing Environmental Protection Agency-sponsored work. Within General Electric, ESPD will be supported by Corporate Research and Development for hot-gas cleanup technology, by the Gas Turbine Division for gas turbine design/technology, and by the Projects Engineering Operation of the Installation and Service Engineering Business Division for commercial power plant balance-of-plant design and costing.

TITLE:

Desulfurization of Coal in Fluidized Bed Reactor

AUTHOR:

G.B. Haldipur and T.D. Wheelock

ADDRESS:

Department of Chemical and Nuclear Engineering, Energy and Mineral Resources
Research Institute, Iowa State University Ames, Iowa 50011

REFERENCE:

Am. Chem. Soc., Div. of Fuel Chem., Preprints, 22 (2), 50 (1977)

SUMMARY:

The work reported here was undertaken to determine the feasibility of desulfurizing a high sulfur bituminous coal from an Iowa mine by treatment at moderately elevated temperatures in a fluidized bed reactor with either oxidizing, neutral, or reducing gases. Nearly isothermal experiments were carried out with a small fluidized and coal weight loss for different conditions of temperature and gas composition. Also the treatments were applied to both run of mine coal and beneficiated coal. In addition the off-gas composition was measured during some experiments to determine the distribution of various sulfur and other compounds and to estimate the heating value of the gas. Finally consideration was given to the possibility of desulfurizing the off-gas and using it as a clean fuel to burn along with partially desulfurized coal char in the same plant in order to meet air pollution control regulations.

TITLE:

A Review of Current Information to Save Ecological and Health Relate Aspects of Trace Metals into the Environment Associated with the Combustion of Coal

AUTHOR:

Merrill Heil

Address:

Health and Safety Laboratoty
Energy Research and Development Administration
New York, New York 10014

REFERENCE:

HASL-320 (NTIS)

SUMMARY:

The Middle East oil embargo of 1973-74 has resulted in the United States initiating programs which are designed to lead to energy independence. These program will cause:

(a) an increase in the use of coal combustion for electric power generation, and

(b) an increase in the production of fuels and chemical produced synthetically from coal

This report is a review of the literature on one class of these pollutants, trace elements, their occurrence in the environment and their potential toxicity to man.

TITLE:

Power Plant Cooling Water Chlorination in Northern California

AUTHOR:

S. Hergott, David Jenkins, and Jerome F. Thomas

ADDRESS:

College of Engineering and School of Public Health
University of California
Berkely, California 94720

REFERENCE:

UCB/SERL No. 77-3

SUMMARY:

This research program was designed to determine the nature, levels, and persistence of "chlorine" residuals in the cooling water effluents of power plants located in the around the San Francisco Bay Area. Plants were located at Potrero and Hunters Point (San Francisco Bay), Contra Costa (San Joaquin River), Pittsburg (Suisun Bay), and Moss Landing (Monterey Bay).

A survey was conducted of chlorination practices at five power plants owned and operated by the Pacific Gas and Electric Company. Frequency and duration of chlorination varied significantly from plant to plant and was controlled analytically by the orthotolidine and/or amperometric methods. All the plants plan to change to using the amperometric method for future control purposes.

In-plant studies were conducted during chlorination cycles to determine oxidant residuals at both the condenser inlets and at a point near the outfall. Both free and total oxidant residuals were measured amperometrically for most studies. The DPA-FAS method was included in later studies to gain a better understanding of the nature of the oxidant residual. These results indicated that most of the oxidant residual at the Hunters Point and Moss Landing power plants was bromine residual.

Decay studies were conducted at the plant sites on the chlorinated cooling water collected at the outfall. The slowest decay was observed at the Contra Costa plant where the cooling water was the freshest. The most rapid decay was at the rate of decay at all locations.

TITLE:

Coal Creek Station Steam Generators

AUTHOR:

W.W. Hickok[1], D.A. Taylor[2], R.W. Dutton[3], and R.C. Keirstead[4]

ADDRESS:

[1]Cooperative Power Power Association, Minneapolis, Minn.
[2]United Power Association, Elk River, Minn.
[3]Black and Veatch Consulting Engineers, Kansas City, Missouri
[4]Combustion Engineering, Inc., Windsor, Conn.

REFERENCE:

Paper presented at Lignite Symposium, May 18-19, 1977, Grand Forks, North Dakota.

SUMMARY:

Cooperative Power Association and United Power Association are the owners of the Coal Creek Station in central North Dakota. Two generating units with a gross output of 550 Mw each are now under construction. Commercial operation of Unit 1 will begin in November 1978, with Unit 2 starting one year later. The Coal Creek Station is a mine-mouth plant and will burn lignite supplied concurrently from two pits operated by a subsidiary of the North American Coal Company. Sufficient fuel for the life of the plant is within 10 miles of the steam generators. The fuel supplier will deliver crushed lignite to within 1.4 miles and it will then be transported the remaining distance to the boilers by conveyor belts.

The steam generators are balanced draft Combustion Engineering reheat units rated at 3,736, 961 pounds of steam per hour at 2620 psig and 1005°F with 1005°F reheat. Steam temperature will be controlled with the tilting tangential firing system as well as with desuperheating. Overfire air will minimize NOx emissions. Each steam generator uses two trisector air heaters with two primary and two secondary air fans to provide independent heating of the primary air used to dry the high moisture content lignite in the pulverizers.

The flue gas treating systems of the two generating units are independent. Gas leaving the air heaters flows through precipitators that remove 99.5 percent of the dry solid particulate matter. The induced draft fans are situated between the precipitators and the scrubbers. The scrubbers are designed to remove 90 percent of the SO_2 from up to 60 percent of the flue gas. The remainder of the flue gas bypasses the scrubbers and is used to reheat the scrubbed gas. Emissions from the 650-foot brick-lined stacks will be well under regulatory limits.

Coal-Fired Power Plants

TITLE:

Chemical Comminution: A Process for Liberating the Mineral Matter from Coal

AUTHOR:

P. H. Howard and R. S. Datto

ADDRESS:

Syracuse Research Corporation, Syracuse, New York 13210

REFERENCE:

Am. Chem. Soc., Div. of Fuel Chem. Preprints, 22 (2), 62 (1977).

SUMMARY:

Chemical comminution provides a unique way to crushing coal for mineral matter liberation. Instead of mechanical size reduction, the coal is treated with a chemical (usually ammonia gas or a concentrated aqueous ammonia solution), resulting in selective breakage which appears to occur along the bedding planes and along the mineral matter (e.g. pyrite) and maceral boundaries. This paper reviews current techniques for the application of chemical comminution of coal and discusses such pertinent topics as effective chemicals for comminution of coal, effects of reaction conditions, effect of coal type and chemical reaction of the comminuting chemical and coal.

TITLE:

Trace Element Behavior in Coal-Fired Power Plant

AUTHOR:

John W. Kaakinen[1], Rober M. Jordan[2], Mohammed H. Lawasani[1], and Ronald E. West[1].

ADDRESS:

[1]Department of Chemical Engineering, University of Colorado, Boulder, Colo. 80302.

[2]Department of Civil and Environmental Engineering, University of Colorado, Boulder, Colo. 80302

REFERENCE:

Environmental Science and Technology, Vol. 9, No. 9, 862(1975).

SUMMARY:

Measurements of the amounts of 17 elements in the inlets and outlets of a pulverized-coal-fired power plant indicate that Al, Fe, Rb, Sr, Y, and Nb were at essentially constant concentrations in all outlet ashes, and that concentrations of Cu, Zn, As, Mo, Sb, Pb, and Se were generally lowest downstream toward the stack. A model was developed for the enrichment behavior in downstream ashes of this latter group of elements assuming that these elements vaporize in the furnace and then condense or absorb onto fly ash, smaller particles have larger specific surface area and thus will have greater concentrations of these elements, and increasing proportion of smaller particles in downstream fly ashes results in enrichment of these elements. Experimental enrichment values for Zn, As, Mo, and Sb agree with values predicted by this model.

TITLE:

Total Mercury Mass Balance at a Coal-Fired Power Plant

AUTHOR:

C. William Kalb

ADDRESS:

TRA-DET Laboratories
Columbus, OH 43212

REFERENCE:

Advances in Chemistry 141, 154, 1975

SUMMARY:

A series of mercury mass balances was obtained at a coal-fired power plant by comparing the volatile and particulate mercury in the stack gas stream to the mercury initially in the coal, corrected for the mercury adsorbed and retained by the various ashes. These data were used to determine the fate of the mercury in the combustion process and to check the accuracy of the volatile mercury sampling procedure (gold amalgamation). The bottom ash had the lowest mercury concentration of the ash samples collected, and the mercury concentration increased as one proceeded through the ash collection system from the initial mechanical ash to the electrostatic ash. The mercury recovered in the various ashes represented about 10% of the total mercury introduced in the raw coal.

TITLE:

Potentially Hazardous Emissions from the Extraction and Processing of Coal and Oil

AUTHORS:

H. Lebowitz, S. Jam, G. Smithson, Jr., H. Nack, J. Oxley, G. Cavanaugh, C. Burklin and J. Dickerson

ADDRESS:

Battelle, Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201

REFERENCE:

P.O. 241 803 (NTIS)

SUMMARY:

The report lists potentially hazardous materials which may be associated with the air, water, and solid waste from a refinery, a coke plant, a Lurgi high-Btu gas process, and the solvent refined coal process. Fugitive loss was identified as the major emissions source in the refinery, although its composition is difficult to quantify. Coking is the most offensive of the four processes assessed. Coal gasification may produce materials as dangerous as those from the coke plant, but the former will probably be more contained than coke oven emissions. The environmental impact of coal liquifaction is not well defined; however, liquefaction products will probably be more hazardous than crude oil products, and their refining and utilization will be worse offenders than corresponding petroleum operations. The study indicates that available documents are not adequate to develop an accurate list of potentially hazardous emissions from these four processes. A detailed assessment of the processes, field sampling, and analysis are needed to identify the potentially hazardous emissions more accurately.

TITLE:

On-Line Particulate Analysis Instrumentation

AUTHOR:

Leeds and Northrup Company

REF:

Coal Power and Combustion (Jan-Mar 1977)
DOE/ET-0025/1
UC-90E

SUMMARY:

An on-line particulate analysis instrument is being developed by Leeds & Northrup Company, under ERDA sponsorship, for pressurized fluidized-bed combustion systems. The objective of this project is to design and construct a prototype instrument to measure particulate loadings and particle size distributions in high temperature gas streams and to evaluate this instrument on pressurized fluidized-bed combustion systems. This type of instrumentation will enable near real-time monitoring and analysis of gas entrained particules to evaluate performance of particle separators and to record the size and concentration of particles at the inlet to gas turbines in direct combustion systems. This capability will provide critically needed information relative to analysis of turbine blade erosion problems.

TITLE:

Combined Cycle Research Program

AUTHOR:

Massachusetts Institute of Technology

ADDRESS:

Cambridge, MA

REF:

Coal Power and Combustion (Jan-Mar 1977)

SUMMARY:

Massachusetts Institute of Technology was commissioned by the Energy Research and Development Administration to provide essential data for the future development of combined cycle power plants. Gas turbine -- steam turbine combined cycle power plants, operating on coal or coal-derived fuels, are thought by many experts to be the most practical and efficient choice for the next generation electric power production. The major benefits of this combined cycle system are the potential attainment, at relatively low risk and development cost, of high efficiences while maintaining pollutant emissions within environmental specifications.

TITLE:

Modeling of Fluidized Bed Combustion Processes

AUTHOR:

Massachusetts Institute of Technology

REF: Coal Power Combustion (Jan-Mar 1977)

SUMMARY:

The modeling of the fluidized-bed combustion of coal is planned by the Massachusetts Institute of Technology (MIT) under this program sponsored by ERDA. The specific objective of the contract is to develop a phenomenologically-based system model for the coal-fired fluidized-bed combustion process.

TITLE:

Atmospheric Fluidized-Bed Component Test and Integration Unit (AFT/CTIU)

AUTHOR:

Morgantown Energy Research Center

ADDRESS:

Morgantown, WV

REF:

Coal Power and Combustion (Jan-Mar 1977)

SUMMARY:

The AFBC/CTIU is a coal-fired boiler which consists of a three-cell fluidized-bed combustor with the beds stacked one above the other. The bottom two cells burn coal and the third (or top) cell, the carbon burnup cell (CBC), burns the residual carbon in the ash. Ash removal from flue gases will be in cyclone separators with reinjection for carbon burnup in the separate carbon burnup cell or within either coal burning cell. Final gas cleanup will be effected by bag filter collectors.

TITLE:

Pressurized Fluidized-Bed Combustion Research

AUTHOR:

National Research Development Corporation

ADDRESS:

London, England

REF:

Coal Power and Combustion (Jan-Mar 1977)

SUMMARY:

The National Research Development Corporation (NRDC), in conjunction with the British Coal Utilization Research Association, Ltd. (BCURA), is studying pressurized fluidized-bed combustion from the point of view of minimizing pollution, especially from high-sulfur coals; avoiding excessive maintenance because of corrosion in conventional plants; and reducing capital and operating costs of electric power generating systems. The program enables ERDA to obtain combustor performance data on systems of substantial size, while obtaining additional research information. The specific purpose of this contract is to establish the effect on performance of:

Fouling of turbine blades

Emmission of alkalis and sulfur and nitrogen oxides

Bed behavior (clinker formation) at higher temperatures (1650°F to 1750°F) than previously used for this type of combustor (1450°F).

Coal-Fired Power Plants

TITLE:

Pilot Plant Scrubbing of SO_2 with Fly Ash Alkali from North Dakota Lignite

AUTHOR:

Harvey M. Ness, Frank I. Honea, and Everett A. Sondreal

ADDRESS:

Greand Forks Energy Research Center, ERDA

REFERENCE:

Paper presented at
Lithte Symposium, May 18-19, 1977, Grand Forks, North Dakota

SUMMARY:

The test program conducted by GFERC was designed to investigate parameters affecting sulfur dioxide removal efficiencies using only fly ash from a cyclone-fired boiler under conditions representative of long-term steady-state conditions. Conclusions of the GFERC program are:

1. At a sulfur dioxide concentration of 1000 ppm-dry, the NSPS requirement can be met and exceeded at L/G of 30 using only the average amount of fly ash available from a cyclone-fired boiler (CaO/SO_2 about 0.6).
2. At a sulfur dioxide concentration of 1800 ppm-dry and a L/G of 60, about 40 pct supplemental alkali must be added with fly ash to meet the NSPS emission requirement.
3. Long-term operation at low pH (less than pH 5) will result in dissolved solid levels of about 10 pct.
4. At a pH of about 3.5, 100 pct of the fly ash calcium oxide was utilized; below pH 3.5, up to 75 pct of the total fly ash alkali (214 pct based on CaO) was utilized.
5. The level of recirculated suspended solids had no effect on sulfur dioxide removal.
6. Increasing levels of recirculated suspended solids up to 6 pct slightly decreased the level of calcium sulfate super saturation; suspended solid levels greater than 6 pct had a negligible effect on degree of calcium sulfate saturation.
7. An increase in soluble sodium levels from a normal 1.5 pct and eliminated all traces of scale formation.
8. An increase in soluble magnesium levels from a normal 1.2 pct to 3 pct marginally increased sulfur dioxide removal by 5 to 10 pct.
9. The scrubber system was operated essentially scale-free throughout the eight-month test program.

TITLE:

Externally Fired Gas Turbine for Modular Integrated Utility System (MIUS)

AUTHOR:

Oak Ridge National Laboratory

ADDRESS:

Oak Ridge, TN

REF:

Coal Power and Combustion (Jan-Mar 1977)
DOE/ET-0025/1
UC090E

SUMMARY:

A fluidized-bed coal combustor for an externally fired closed-cycle gas turbine is being designed by Oak Ridge National Laboratory (ORNL) as part of the Modular Integrated Utility System (MIUS).

TITLE:

Boiler Tube Bundle and Burner Module Tests with Potassium

AUTHOR:

Oak Ridge National Laboratory

ADDRESS:

Oak Ridge, TN

REF:

Coal Power and Combustion (Jan-Mar 1977)
DOE/ET-0025/1
UC-90E

SUMMARY:

Boiler fuel consumption can be reduced by increasing the efficiency of thermodyanmic cycles. Little has been done to increase efficiencies since the upper practicable temperature limit (about 1000°F) for the steam cycle was reached more than 25 years ago. Thermodynamic efficiency is directly related to the absolute temperatures at which heat enters and leaves the process. Thus, to increase thermal efficiency further, temperatures must be higher, which implies the use of other working fluids. A leading candidate for an advance thermodynamic cycle is a potassium or cesium vapor cycle. Oak Ridge National Laboratory (ORNL) is conducting tests of a boiler tube bundle module and burner assembly with potassium.

TITLE:

Multicell Atmospheric Pressure Fluidized-Bed Boiler

AUTHOR:

Pope, Evans, And Robbins, Inc.

ADDRESS:

New York, NY

REFERENCE:

Coal Power and Combustion (January-March 1977)
DOE/ET - 0025/1
UC - 90E

SUMMARY:

A multicell atmospheric pressure fluidized-bed boiler is being developed by Pope, Evans and Robbins, Inc. (PER), under the sponsorship of ERDA. The objective of this program is to design, construct, and operate a prototype multicell fluidized-bed boiler at an electric utility power station as an environmentally acceptable method of burning high-sulfur or corrosive coals without excessive maintenance problems. The system is to have a capacity of 30 megawatts (Mw) and is to be operated under practical electric utility conditions. PER is also conducting a laboratory research program to optimize boiler hardware and operational parameters. Experience gained from designing and operating the boiler and from laboratory research will be used as the basis for scaling up to a utility-sized system.

TITLE:

Diagonistic Assessment For Advance Power Systems

AUTHOR:

Sandia Laboratories

ADDRESS:

Livermore, CA

REF:

Coal Power and Combustion (Jan-Mar 1977)
DOE/ET-0025/1
UC-90E

SUMMARY:

The objective of the first phase of the program is a review and assessment of diagonostic techniques which are needed to characterize the flow at the combustor exit and turbine inlet in advance, open-cycle gas turbine systems which will be used for stationary power generation. These systems will be designed for firing with pulverized coal, coal-derived liquid and gaseous fuels, and heavy residual fuels.

TITLE:

Sulfur Removal From Coals: Ammonia/Oxygen System

AUHTOR:

S.S. Sareen

ADDRESS:

Ledgemant Laboratory, Kennecott Copper Corporation, 128 Spring Street,
Lexington, Mass. 02172

REFERENCE:

Am. Chem. Soc., Div. of Fuel Chem. Preprints, 22(2), 93(1977).

SUMMARY:

This paper discusses the sulfur removal from coals using an ammonia/oxygen system which removes almost all of the pyritic sulfur and up to 25% of the organic sulfur in about 2 hrs. Because organic sulfur removal necessarily implies coal carbon losses, a balance must be struck between the amount of organic sulfur removed and the thermal losses that can be economically tolerated from the coals being cleaned. Although no effort has been made to optimize the system reported here, the results of BTU loss, oxygen consumption, retention time, etc. are fairly consistent with the oxygen/water system for pyrite removal from coal. The carbon losses as might be expected, are somewhat higher. Furthermore, the data presented here can be used to construct an optimization scheme for future development work.

TITLE:

X-Ray Study of the Structure of Cokes Carbonized at Different Temperatures

AUTHOR:

R.R. Schehl and R.A. Friedel

ADDRESS:

Pittsburgh Energy Research Center, Pittsburgh, Pa.

REFERENCE:

Bureau of Mines Report of Investigations 7888, 1974

SUMMARY:

The Bureau of Mines analyzed the structure of a high-grade metullurgical coke, carbonized at different temperatures in the range 500° to 1,111°C, through X-ray diffraction studies. Growth in the crystallite size with increasing coking temperature was calculated from profile analysis and compared with values obtained from the radial distribution function. The carbonization temperature appeared to have little influence upon the stack height, whereas the layer diameters more than doubled in size between 500° and 1,000°C. These results are comparable to those obtained from other studies of poorer quality cokes.

TITLE:

Removal of Fly Ash from Stack Gases by Electrostatic Precipitation

AUTHOR:

Everett A. Sondreal

ADDRESS:

Grand Forks Energy Research Center, Grand Forks, N. Dakota

REFERENCE:

GFERC/QTR - 76/3 UC 90

SUMMARY:

Combustion of some low-sulfur Western coals in powerplant boilers results in fly ash which is difficult to remove by means of electrostatic precipitation (ESP). The goal of this project is the development of means of reducing the uncertainty in the design of ESPs for such coals. A combination of laboratory and pilot-scale techniques is under study.

Work is continuing on the design and construction of a 75-lb/hr. pc-fired furnace and pilot-scale ESP for studies on representative fly ashes prepared from test coal samples. The major construction phase of this work should be completed during the next quarter. The furnace, which was described in a previous quarter, has been fabricated, and assembly is in progress. The pilot-scale ESP designed this quarter will have a tubular configuration because of its greater flexibility in achieving operating parameters over the ranges of interest.

Computer modeling and the study of factors affecting the measurement of fly ash resistivity are continuing. The development of new and improved techniques for characterizing fly ash is an ongoing activity.

A test program relating ESP performance to flue gas mositure content is planned for next quarter. The excellent record of performance for ESPs operating on powerplants burning North Dakota lignites, compared with poor performance on some subbituminous coals, has generated an interest in the effect of the high moisture content of lignite. The existing pilot ESP and ash-fouling furnace will be utilized for this study.

Coal-Fired Power Plants

TITLE:

Control of Ash Fouling

AUTHOR:

Everett A. Sondreal

ADDRESS:

Grand Forks Energy Research Center, Grand Forks, N. Dakota

REFERENCE:

GFERC/QTR - 76/3 UC 90

SUMMARY:

Fouling of boiler heat transfer surfaces by ash from low-rank coals (subbituminous coals and lignite) is a continuing problem, resulting in reduced boiler efficiency and availability. The problem has been found to be closely related to the concentration of sodium in the coals, with the ash content of coal also being a factor. No effective means has yet been found for preventing formation of fire-side ash deposits in the combustion of coal with high sodium levels. Progress has been made in studies on the mechanism of ash fouling, but additional work is necessary to resolve the problem.

A pilot pulverized-coal combustor of 75-lb/hr capacity, designed and constructed at GFERC, is used to measure fouling under controlled conditions. In this way, relatively small samples of candidate coals can be tested prior to plant design, and utilization criteria can be established on the basis of the characteristics of the coal to be used.

A new additive delivery system is being designed to facilitate pilot plant testing of a proprietary anti-fouling boiler additive.

A test has been made in which the mixing phenomenon of ash particles in a pulverized coal flame was studied. Interpretation of results await microprobe analysis of fly ash particles collected during the test.

A paper on the ash fouling potential of Western subbituminious coals in the pilot combustor has been prepared for the 1976 meeting of the American Power Conference in April.

Work is continuing on the microscopic and microprobe examination of coal ash deposits in order to delineate the ash fouling mechanism of Western subbituminous coals.

TITLE:

Particle Measurement in Fluidized-Bed Combustion Systems

AUTHOR:

Spectron Development Laboratories, Inc.

ADDRESS:

Costa Mesa, CA

REF:

Coal Power and Combustion (jan-Mar 1977)
DOE/ET-0025/1
UC-90E

SUMMARY:

The primary objective of this program is to assess the capability of an advanced diagnostic technique to make required particle field measurements to determine efficiencies of particle separators and filters, and to monitor particle environments at gas turbine inlets of combined cycle systems. Measurements will be made at the Argonne National Laboratory (ANL) FBC facility, and will provide data on particle size and velocity distribution in the combustion gas flows. Currently available SDL lasar instrumentation will be used for data acquisition.

TITLE:

Environmental Effects from Leaching of Coal Conversion By-Products

AUTHOR:

Wayne P. Van Meter
Ronald E. Erickson

ADDRESS:

University of Montana, Missoula, Montana 59801

REFERENCE:

FE-2019-3

SUMMARY:

Leaching column operations and eluant analyses have continued, using residue materials from Consolidation Coal (CO_2 Acceptor, Rapid City) and the Institute of Gas Technology (Hygas, Chicago). Results are reported from six runs; seven others were terminated before completion because of various mechanical difficulties. Concentrations in the effluent of hydroxide, calcium, magnesium, sodium, potassium, and manganese, and the pH, are reported in graphical form as functions of the volume of eluant. The concentrations of copper, cadmium, nickel and zinc were found in all runs to be below their atomic absorption detection limits. The CO_2 Acceptor residue releases large amounts of the soluble strong base calcium hydroxide when extracted with water. The ammonium acetate eluant does, as expected, produce rapid release of all the metals found to be present in measurable amounts. The level of participation of students is briefly reported.

TITLE:

Studies on the Co- Cu- Al_2O_3 Catalyst System for Conversion of CO and H_2 to Light Hydrocarbon Products.

AUTHOR:

Chen-Hsyong Yang, M.K. Zaman Khan, F.E. Massoth and A.G. Oblad.

ADDRESS:

Department of Mining, Metallurgical and Fuels Engineering, University of Utah, Salt Lake City, Utah 84112

REFERENCE:

Am. Chem. Soc., Division of Fuel Chem. Preprints; 22 (2), 148 (1977).

SUMMARY:

Extensive studies of different catalysts for the conversion of CO and H_2 light hydrocarbons have been reported. Among others, a catalyst consisting of cobalt and copper supported on alumina was found to be promising for achieving the above-mentioned objective. In this paper, additional studies on this catalyst system were reported. Work included catalyst characterization and testing of various catalyst formulations.

TECHNICAL REPORTS:
COAL-LIQUEFACTION PLANTS

TITLE:

Development of the CO-Steam Process for Liquefaction of Lignite and Western Subbitiminous Coals

AUTHOR:

Everett A. Sondreal, Curtis L. Knudson, Joseph E. Schiller, Thomas H. May

ADDRESS:

U.S. ERDA, Grand Forks Energy Research Center Grand Forks, N.D.

REFERENCE:

Technology and Use of Lignite Symposium
Grand Forks, N.D. May 1977)GFERC/IC-77/1) page

SUMMARY:

The CO-Steam process is a second-generation coal liquefaction technology for conversion of low-rank coals into environmentally acceptable liquid boiler fuels, and with additional hydrogenation, into refined products including gasoline, distillate heating oil, and chemical feedstocks. Work on reaction kinetics is conducted in a modified one-liter batch autoclave which is capable of hot reactor charging and timed sampling of both gas and liquid products. Kinetic data have been obtained on the rate of disappearance of carbon monoxide and hydrogen reacting with a selected North Dakota lignite and on simultaneous changes in the molecular weight distribution and composition of the liquid product. Results point to the possibility of more rapid conversion by reaction with carbon monoxide through moderate increase in reaction temperature and improved use of hydrogen donor compounds that are produced in the process.

TITLE:

Operation of Solvent-Refined Coal Pilot Plant

AUTHOR:

Southern Company Serivces, Inc.

ADDRESS:

Birmingham, AL

REF:

Coal Liquefaction (Jan-Feb 1977)
DOE/ET-0026/1
UC-90D

SUMMARY:

The SRC process converts high-sulfur, high-ash coals to a clean distillate fuel and a clean high-Btu gas. The pulverized coal is mixed with two to three parts process-derived solvent. Hydrogen is then added to the coal-solvent slurry. The mixture is pumped to a preheater and then fed into a single-stage reactor or dissolver which operates at 800°-875°F. Approximately 93 percent of the carbonaceous material in the coal feed is dissolved during the residence time of approximately 45 minutes. The product gases from the dissolver are separated and sent to a clean-up system to remove the hydrogen sulfide (about 60 percent of the organic sulfur in the coal is converted to hydrogen sulfide) and convert it to elemental sulfur. The slurry is then subjected to a mineral separation step wherein the undissolved solids are removed. Process solvent is recovered from the coal solution by distillation and recycled to slurry the coal feed. The residue which remains is the solvent refined coal product, which solidifies at about 350°F.

TITLE:

Gasification of Residual Coal Liquefaction Products

AUTHOR:

Texaco, Inc.

REF:

Coal Liquefaction (Jan-Mar 1977)
DOE/ET0026/1
UC-90D

SUMMARY:

The thermal efficiency of a coal liquefaction plant using a process that requires hydrogen or synthesis gas is dependent upon the efficient recovery of that gas from the non-liquefied fraction of the coal. This material, together with inorganic ash and some fraction of the converted coal, can be recovered after liquefaction as a residue from a vacuum distillation tower. The chemical and physical properities of the high-ash coal-derived residues determine both and method of introducing these materials into the gasifier and the efficiency of the gasifier. As Texaco has demonstrated that high-ash coal-derived residues can be gasified directly using the Texaco coal gasification process, the necessary design parameters will be determined for the materials resulting from ERDA-sponsored liquefaction projects.

Coal Liquefaction Plants

TITLE:

Clean Boiler Fuel Demonstration Plant

AUTHOR:

Union Carbide Co., Inc.

ADDRESS:

New York, NY

REF:

Coal Demonstration Plants (Jan-Mar 1977)
DOE/ET-0027/1
UC-89

SUMMARY:

The Coalcon Department of Union Carbide is under contract with ERDA to design a demonstration plant for producing clean boiler fuels from high-sulfur coal. The plant was to be fully integrated in all phases of processing, from receipt of coal to delivery of a finished product. The design was geared to be environmentally acceptable by cleanup of all waste streams, and energy efficient by recovery of all by-products.

TITLE:

Characterization of Coal Liquids

AUTHOR:

UOP, Inc.

ADDRESS:

Des Plains, IL

REF:

Coal Liquefaction (Jan-Mar 1977)
DOE/ET-0026/1
UC-90D

SUMMARY:

Four tasks are identified under this program. The first task involves two stage continuous catalyst bed hydrocracking of two coal liquid distillates through continuous fixed catalyst bed hydrotreating and fluid catalytic cracking units. The third task covers processing of two naphthas through continuous refining-reforming bench scale units. The fourth task involves the correlation of feed-stock properties and process conditions with product yields and qualities which can be composed into a simple process model.

TITLE:

Clean Coke Process

AUTHOR:

U.S.S. Engineers and Consultants, Inc.
United States Steel Corporation

ADDRESS:

Pittsburgh, PA

REF:

Coal Liquefaction (Jan-Mar 1977)
DOE/ET-0026/1
UC-90D

SUMMARY:

The Clean Coke process combines coal carbonization and hydrogenation in an environmentally acceptable manner to produce solid, liquid, and gaseous fuel products. No external hydrogen source is required and only minimal amounts of external energy will be consumed.

TITLE:

Coal Utilization: The Emission Control Alternative

AUTHOR:

Lawrence H. Weiss

ADDRESS:

Chem System Inc., 747 Third Avenue, New York, NY 10017

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering Conference Proceedings, September 1976.

SUMMARY:

The direct combustion of coal produces air-borne emissions of sulfur oxides (SOx). The main alternatives for limiting SOx emissions are conversion of the coal to a clean fuel or fuel gas desulfurization (FGD). Neither is well-established in the U.S.A. The most economic coal conversion processes for power generation are Lurgi gasification and H-Coal liquefaction. Three representative FGD processes were selected for comparison. The unit cost estimated for electric power generation using the limestone slurry FGD process is 45.9 mil/kwh, for the Wellman-Lord sodium-based FGD process it is 46.7 mil/kwh, and for the Atomics International ACP FGD process it is 44.6 mil/kwh in 1980 costs. Intermediate BTU gas from a Lurgi installation gives electricity at 62.1 mil/kwh on the same basis. Similarly, syncrude from an H-Coal plant has a generation cost of 57.5 mil/kwh. The higher capital required for the coal conversion plants plus their low conversion efficiencies lead to the higher costs. However, site-specific factors may favor production of clean fuels over the installation of FGD.

TITLE:

Analysis of Volatile Polar Organics in Untreated By-Product Waters from Coal Conversion Process

AUTHORS:

Curt M. White and Charles E. Schmidt

ADDRESS:

U.S. Department of Energy
Pittsburgh Energy Research Center
4800 Forbes Avenue
Pittsburgh, PA 15213

REF:

American Chemical Society
Div. of Fuel Chem. 23, #2, (Mar 12-17 1978)

SUMMARY:

Analysis of by-product waters from coal conversion processes is important because the need for constructing large-scale coal liquefaction and gasification plants is increasing. Coal liquefaction and gasification technologies will use or produce water which must be made environmentally acceptable before discharge from the plant. However, some gasification processes plan to recirculate a major portion of the process water within the plant. It is therefore necessary to obtain qualitative and quantitative data concerning the organic constituents present in these process waters in order that effective water treatment technologies can be developed and evaluated. This knowledge would also provide insight into the potential environmental impact of coal conversion processes.

TITLE:

Coal Liquefaction

REFERENCE:

Shaping Coal's Future through Technology, 1974-1975, Office of Coal Research, Washington, D.C. 20402 Stock #024-014-00112-2

SUMMARY:

Coal liquefaction is gaining emphasis as a promising approach to supplement U.S. energy needs by providing a non-polluting fuel oil. Because it has less materials problems and higher conversion efficiency, liquefaction may achieve commercialization sooner than gasification even though the latter has been developed more vigorously in the recent past.

Today's modern catalyst also promote sulfure removal when coal or extract is hydrogenated to fuel oils, removing this pollutant. The entire range of liquid products, including fuel oil, gasoline, jet fuel, and diesel oil, can be produced from coal by proper choice of conditions in all the above processes.

Modern improvements are providing better catalysts, better reactor designs, and better materials of construction, leading to more attractive processing economics and less capital investment. Coal liquefaction can now be achieved at milder conditions, more rapidly, and at less cost than the wartime German operations or the Sasol plant in South Africa.

TITLE:

Development of the CO-Steam Process for Liquefaction of Lignite and Western Subbituminous Coals

AUTHOR:

E.A. Sondreal, D.L. Knudson, J.E. Schiller, and T.H. May

ADDRESS:

Grand Forks Energy Research Center, Energy Research and Development
Administration, Grand Forks, North Dakota

REFERENCE:

Preprints of the 9th Biennial Lignite Symposium, Grand Forks, ND
5/18-19, 1977

SUMMARY:

CO-Steam is a second generation coal liquefaction technology for converting low-rank coals to environmentally acceptable liquid boiler fuel, and with fractionation or additional hydrogenation, to distillate heating oil, gasoline, and chemical feedstocks. The process utilizes the reaction of carbon monoxide and steam on coal with or without the addition of catalyst. Favorable reaction conditions are 4000 psig and 460°C. Work on the CO-Steam process at the Grand Forks Energy Research Center was started in 1975; this report presents the significant aspects of the progress to date.

Coal Liquefaction Plants

TITLE:

Development of a Continuous Dry Coal Screw Feeder

AUTHOR:

Ingersoll-Rand Research, Inc.

ADDRESS:

Princetown, NJ

REF:

Coal Demonstration Plants (Jan-Mar 1977)
DOE/ET-0027/1
UC-89

SUMMARY:

Development of a continuous dry coal screw feeder is being conducted by Ingersoll-Rand Research, Inc. through ERDA sponsorship. The feeders are to be developed through the pilot plant stage, with the engineering and economic viability evaluted throughout the development process. The end result of the research will be a recommendation by Ingersoll-Rand of coal feed injector equipment that will be compatible with projected demonstration plant requirements. The successful developement of a continuous dry coal feeder would have a significant impact on coal processing. The equipment could be used in both high-and low-Btu gasification plants and also in coal liquefaction systems.

TITLE:

Technical Assistance Services

AUTHOR:

Ralph M. Parsons Company

ADDRESS:

Pasadena, CA

REF:

Coal Demonstration Plants (Jan-Mar. 1977)
DOE/ET-00271
UC-89

SUMMARY:

The Ralph M. Parsons Company is providing technical assistance services to ERDA with the objective of developing and demonstrating practical processes for producing liquid and/or solid fuels from coal. Under this program, initiated in 1972 and updated in 1974, Parsons is:

Preparing conceptual designs and economic evaluations for commercial plants.

Evaluating pilot plant perfomance and other experimental programs.

Evaluating unit operations and processes for possible applications in coal processing, including design and construction of pilot plants.

Evaluating proposals for new work and for changes in ongoing work.

TITLE:

Engineering and Technical Support

AUTHORS:

U.S. Army Corps of Engineers
Huntsville Division

ADDRESS:

Huntsville, AL

REF:

Coal Demonstration Plants (Jan-May 1977)
DOE/ET-0027/1
UC-89

SUMMARY:

Under the interagency agreement between ERDA and the Office of the Chief of Engineers, U.S. Department of the Army, the U.S. Army Corps of Engineers is providing ERDA with engineering and technical support. This contract, initiated in mid-1974, involves the services of the Corps of Engineers engineering forces to provide technical services for demonstration plant design, construction, and related support for such projects and at such locations as requested by ERDA.

TITLE:

Chemical Bond Cleavage During Asphaltene Formation

AUTHOR:

B.M. Benjamin, V.F. Raaen, G.W. Kabalka, and C.J. Collins

ADDRESS:

Chemistry Division, Oak Ridge National Laboratory, Oak Ridge, TN 37830

REFERENCE:

Am. Chem. Soc., Div. of Fuel Chem. Preprints, 22 (2), 206 (1977).

SUMMARY:

An important question arising from experiments involving coal liquefaction processes is "which bonds are broken when solid coal is converted to liquids, or to soluble oils, asphaltenes, and preasphaltenes?" Previously, we found that a variety of diaryl-and triarylethanes and ethylenes were found to cleave at the central C - C bond; the derived products were characterized. Certain ethers were found to cleave accompanied by the formation of water.

We have now investigated a large variety of compounds and have found that bonds attaching large groups to the aromatic nucleus of phenols and phenol ethers break easily. Radioactive labeling was also used to determine the presence of any isolated, nonaromatic double bonds.

TITLE:

Commercial Scale Ebullated-Bed Hydroprocessing of Solvent Refined Coal Extract

AUTHOR:

Cities Services Research and Development Company

ADDRESS:

Cranbury, NJ

REF:

Coal Liquefaction (Jan-Mar 1977)
DOE/ET-0026/1
UC-90D

SUMMARY:

Solvent refined coal (SRC) extract is a hydrocarbon mixture containing significant quantities of oxygen, nitrogen sulfur, and ash. SRC extract composition and properties are similar to heavy sour petroleum crude and process-derived residue. These are problem stocks which must be upgraded by treatment with hydrogen before they can be further refined to liquid finished products. Ebullated-bed hydrotreating can upgrade these stocks and maintain continuous operation for extended periods of time as well.

TITLE:

Synthoil Process

REFERENCE:

Coal Liquefaction, Quarterly Report from the Office of Fossil Energy. April-June, 1976, Energy Research and Development Administration, 20 Massachusetts Avenue N.W., Washington D.C. 20545

SUMMARY:

Development of the Synthoil process, initiated by the U.S. Bureau of Mines, is currently being managed by ERDA through the Pittsburgh Energy Research Center (PERC) in Pennsylvania. The objective of this project is to determine the technical and economic feasibility of the process for scale-up to commercial use. Foster Wheeler Energy Corporation is responsible for designing and managing the construction of a 10-ton-per-day process development unit to test the Synthoil process. PERC is conducting support research for the design of the unit. In addition, PERC is monitoring laboratory research on various aspects of the Synthoil process being conducted by Sandia Laboratories, and Argonne National Laboratory. Research being conducted at Exxon Research and Engineering and Battelle Memorial Institute is being monitored by the Morgantown Energy Research Center (MERC) in West Virginia.

TITLE:

Synthoil Process

REF:

Coal Liquefaction (Jan-Mar 1977)
DOE/ET-0026/1
UC-90D

SUMMARY:

The synthoil process is a dehydrodesulfurization process that covers high-sulfur coal to a low-sulfur coal, low-ash synthetic fuel oil. The coal is crushed and dried and mixed with process product oil to form a slurry. The slurry is combined with hydrogen and fed into a fired preheater. From the preheater, the slurry enters a fixed-bed catalytic reactor packed with catalyst pellets, of cobalt molybdate on a silica aluminum base. The product mixture is then cooled and the liquid and unreacted solids are separated from the gases.

TITLE:

Zinc Halide Hydrocracking Process

AUTHOR:

Conoco Coal Development Company

ADDRESS:

Library, PA

REF:

Coal Liquefaction (Jan-Mar 1977)
DOE/ET-0026/1
UC-90D

SUMMARY:

The zinc halide hydrocracking process is designed to maximize the conversion of coal into light distillates by severe catalytic cracking. The coal is dried and pulverized and then introduced into a feed tank where it is slurried with a process-derived recycle oil. The slurry feed is transferred to a hydrocracking reactor where it is mixed with hydrogen and the zinc chloride catalyst. In the reactor, the coal is cracked to distillates in the gasoline within further processing, and a small quantity of very low sulfur, low-nitrogen fuel oil. The gas is subsequently separated from the liquid in a product receiver. Spent catalyst is then fed to a regenerator for catalyst recovery.

TITLE:

Chemicals from Coal

AUTHOR:

Dow Chemical Company

ADDRESS:

Midland, MI

REF:

Coal Liquefaction (Jan-Mar 1977)
COE/ET-0026-/1
UC-90D

SUMMARY:

Historically, coal was used as a chemical feedstock, but petroleum and natural gas were substituted as cheaper feedstocks when they became available. However, because of the recent rising costs and decreasing availability of petroleum and natural gas, The Dow Chemical Company, under sponsorship of ERDA, is studying the possibility of using coal-derived liquids as chemical feedstock. Dow is testing liquids from four coal liquefaction processes (COED, Synthoil, H-Coal, and SRC) in standard petrochemical processing experiments and is evaluating these results to select one process for further study. The selection will be based on process design, quality of chemicals produced, and overall plant economics. For the process selected, further development will include material balances and utility requirements for each major process step, a preliminary process flowsheet, and estimates of captial and operating cost for a commercial plant.

TITLE:

Social, Economic, and Environmental Impacts of Coal Gasification and Liquefaction Plants

AUTHOR:

R.G. Edwards, A.B. Broderson & W.P. Hauser

ADDRESS:

AME Technology, Inc.
Lexington, Kentucky 40505

REFERENCE:

PB 253 747 (NTIS)

SUMMARY:

This work was commissioned by the University of Kentucky Institute for Mining and Minerals Research in order to identify potential impacts on the environment occasioned by the construction and operation of major coal conversion plants.

The principal objective of any good environmental impact assessment is to identify and address potential problems, regardless of the ease of difficulty of their solution, so that adequate attention may be given to their preclusion or solution. An especially searching and penetrating study is required in order that coal conversion plants may be intelligently sited, planned, and designed. We asked for such a study and requested that any and all potential problems be identified and discussed. We realize this may appear to place undue emphasis on the negative aspects of the benefit-cost-impact relationship, but, unfortunately, this seems to be the nature of environmental impact studies. The reader must bear in mind the fact that there are substantial benefits accruing to the establishment of a coal conversion industry which must be properly factored into overall planning considerations.

TITLE:

Coal Liquefaction

AUTHOR:

ERDA

ADDRESS:

Pittsburgh Energy Research Center
4800 Forbes Avenue
Pittsburgh, PA. 15213

REF:

Clean Energy from Coal (p. 6-9)
PERC 1000

SUMMARY;

A major objective of the Pittsburgh Energy Research Center is development of processes intended primarily to produce clean fuel oil from coal. The most advanced of these, the SYNTHOIL process, has progressed to the scale of 10 ton-per-day Process Development Unit (PDU) which is now under construction. Another process, using disposable catalysts, is being tested in a 1/2 ton-per-day unit. A third process, termed COSTEAM, is aimed toward use of low rank coals without a catalyst and with cheaper reacting gases. These different liquefaction processes thus employ various materials and operating conditions to reach similar objectives.

TITLE:

Fluid Coking of Coal Liquefaction Residues

AUTHOR:

Exxon Research and Engineering Company

REF:

Coal Liquefaction (Jan-Mar 1977)
DOE/ET-0026/1
UC-90D

SUMMARY:

The treatment of residual, solids-containing liquids produced by various coal liquefaction processes is important in determining the overall economic viability of the process. Solids are removed from primary coal liquids by methods such as hydrocyclones, vacuum distillation, and solvent deashing. The solids-containing residues from these operation may contain additional valuable liquid products which may be recovered by fluid coking.

TITLE:

Donor Solvent Liquefaction Process

AUTHOR:

Exxon Research and Engineering Company

ADDRESS:

Baytown, TX

REF:

Coal Liquefaction (Jan-Mar 1977)
DOE/ET-0026/1
UC-90

SUMMARY:

Crusted coal is liquefied in a non-catalytic tubular reactor in the presence of molecular hydrogen and the hydrogen-donor solvent. The liquefaction reactor operates at 800-880°F and 1500-2000 pounds per square inch.

The hydrogen-donor solvent is a 400°-850°F boiling range material. The solvent is a catalytically hydrogenated recycle stream fractionated from the middle boiling range of the liquid product. After hydrogenation, the solvent is mixed with fresh coal feed and pumped through a preheat furnace into the liquefaction reactor. Slurry leaving the liquefaction reactor is separated by distillation into gas, naphtha, distillates, and a vacuum bottoms slurry. The vacuum bottoms slurry is coked to produce additional liquids.

TITLE:

Conceptual Design for Advanced Coal Liquefaction Commercial Plant

AUTHOR:

Fluor Engineers and Constructors

ADDRESS:

Irvine, CA

REF:

Coal Demonstration Plant (Jan-Mar 1977)
DOE/ET-0027/1 UC-89

SUMMARY:

Fluor Engineers and Constructors are currently under contract to the Division of Major Facilities Project Management to prepare a conceptual design package for a commercial facility to produce liquid synthetic fuels by an advanced coal liquefaction scheme. The process currently under study is similar to the hydrogen donor solvent concept.

TITLE:

Cresap Test Facility

AUTHOR:

Fluor Engineers and Constructors, Inc.

ADDRESS:

Los Angeles, CA

REF:

Coal Liquefaction (Jan-Mar 1977)
DOE/ET-0026/1
UC-90D

SUMMARY:

In this process, coal is converted to low-sulfur liquid fuel. The coal is first crushed to 100-mesh and then combined with aromatic solvent in a mixer. The coal-solvent slurry is then pressurized and preheated. The slurry passes to an extractor where coal dissolution occurs. The product stream is then treated in a liquid-solid separation unit where the coal extract and solvent are removed, leaving a thickened slurry. This stream is sent to a carbonizer where the material is converted to char, oil, and gas. The oil is recycled to the liquid-solid separation unit and the char and gas are recovered.

TITLE:

Major, Minor, and Trace Elements in the Liquid Product and Solid Residue from Catalytic Hydrogenation of Coals

AUTHOR:

P.H. Given, R.N. Miller, N. Subra and W. Spackman

ADDRESS:

College of Earth and Mineral Sciences, Pennsylvania State University,
University Park, Pennsylvania 16802

REFERENCE:

Advances in Chemistry Series 141, 188, 1975

SUMMARY:

Approximate contents of 14 minor and trace elements in oils produced from three coals by the catalytic hydrogenation process of Gulf Research and Development Co. were determined by emission spectroscopy. The results were compared with corresponding data for the original coals and the solid residues from the process. The contents of ash, sulfur, vanadium, lead, and copper are near or below the limits specified for an oil to be fired directly in a gas turbine while sodium and probably calcium are too high. Titanium appears to be somewhat enriched in the oils analyzed relative to other elements, suggesting its presence in organometallic complexes.

TITLE:

H-Coal Project

AUTHOR:

Hydrocarbon Carbon Research, Inc.[1]
Ashland Synthetic Fuels, Inc.[2]

ADDRESS:

Trenton, NJ[1]
Ashland, KY[2]

REF:

Coal Liquefaction (Jan-Mar 1977)
DOE/ET-0026/1
UC-90D

SUMMARY:

The overall objectives of this project are to further develop the H-Coal process and to demonstrate its technical and economic feasibility on larger scales. The specific objectives are to:

Perform laboratory research on all phases of the H-Coal process, using the existing bench-scale unit and process development unit to establish design criteria.

Design a pilot plant capable of converting 600 tons of coal per day to 2,000 barrels per day of low-sulfur boiler fuel or synthetic crude oil.

Procure equipment and materials for the pilot plant.

Ultimately, the pilot plant will be constructed and operated to provide data for further evaluation of the process and design of a full-size commercial plant.

TITLE:

Filtration Process and Equipment Studies

AUTHOR:

John-Manville Sales Corporation

ADDRESS:

Denver, CO

REF:

Coal Liquefaction (Jan-Mar 1977)
DOE/ET 0026/1
UC-90D

SUMMARY:

The filtration research program is divided into two phases. The objectives of Phase I are to (1) develop basic knowledge of the coal oil filtration process and its dependence on liquefaction process parameters and (2) apply the knowledge gained to improve the performance of filtration operations in existing liquefaction plants. Phase II involves the design and construction of a rotary drum pressurized percoal filter capable of processing the product flow from an existing liquefaction pilot plant. One of the criteria established for a viable system is the capability of filtering in excess of 20 gallons of solid-liquid mixture per square foot per hour. Data obtained from operation of the pilot scale filtration unit will be used to design filters for commercial plants.

TITLE:

Evaluation of Pollution Control in Fossil Fuel Conversion Processes (analytical test plan)

AUTHOR:

C.D. Kalfadelis, E.M. Mager, G.E. Milliman and T.D. Seal

ADDRESS:

Exxon Research and Engineering Company
P. O. Box 8
Linden, New Jersey 07036

REFERENCE:

P.B. 249 845 (NTIS)

SUMMARY:

The report gives results of a preliminary definition of those streams which require analysis to permit an assessment of the pollution potential of the processes in the light of current environmental standards, using a coal gasification process (Lurgi) and a coal liquefaction process (COED) as a basis. It defines methods for sampling indicated streams and analytical procedures which are required to obtain the data. These summaries may be readily modified or adapted to other processes, and expanded to include additional polluting constituents or improvements in analytical procedures.

TITLE:

Aging Characteristics of Coal Liquids

AUTHOR:

Fred S. Karn, Fred R. Brown, A.G. Sharkey, Jr.

ADDRESS:

ERDA, 4800 Forbes Avenue, Pittsburgh, PA 15213

REFERENCE:

Am. Chem. Soc., Div. of Fuel Chem., Preprints, 22 (2), 227 (1977).

SUMMARY:

Materials handling and storage is an important part of any chemical process. The Synthoil process, which converts coal to a low-ash, low-sulfur fuel oil, requires careful storage to control the viscosity of the products. The economics of this process requires a light hydrogenation of coal, and therefore any chemical changes during storage that may increase the viscosity of the product to a level at which it becomes a handling problem must be avoided. Recommended handling procedures can be determined by laboratory studies. Previous studies give a brief resume of the changes in viscosity of Synthoil samples during ambient storage for times up to 120 days. The present report, also based on viscosity measurements, covers a variety of storage conditions which include storage temperatures of 30°-61°C, atmospheres of nitrogen, air and oxygen, both stirred and unstirred samples and ambient light versus darkness. Further studies of these samples based on chemical and instrumental analyses will be reported.

TITLE:

Production of Clean Liquid Fuels from Lignite: Catalytic Hydrotreating of Solvent Refined Lignite Employing Low Surface Area Catalysts and Commercial Catalysts

AUTHOR:

K.J. Klabunde, D.S. Jones, D.H. Ralston, K. Tanabe, M. Govek, V.I. Stenberg, N.F. Woolsey, and R.J. Baltisberger

ADDRESS:

Department of Chemistry, University of ND, Grand Forks, ND 58202

REFERENCE:

Paper presented at:
1977 Ninth Annual Lignite Symposium, May 18-19, 1977 Grand Forks, ND

SUMMARY:

Solvent Refined Lignite (SRL) is a heavy demineralized solid fuel derived from lignite (by Project Lignite of UND). It is highly aromatic and contains a good deal of oxygen and nitrogen. A series of commercial hydrotreating catalysts normally used in the petroleum industry were tested in batch autoclave experiments under moderate pressures of hydrogen to determine which were superior for conversion of SRL to light distillable high quality liquid fuels. It was found that $Ni0$-$Mo0_3$ on Al_20_3 and $Co0$-$Mo0_2$ on Al_20_3 (both from Harshaw) were effective in this process, giving 90% overall conversions with 40-50% going to light liquids and oils. However, these catalysts have very high surface areas, and were originally designed for petroleum feedstocks. Therefore, a series of low surface area, $NiS0_4$-$Mo0_3$/supports were synthesized choosing various catalyst supports with SRL as a feedstock in mind (we now know a great deal about SRL chemical properties). The supports chosen were $Ti0_2$ (α), $Ti0_2$(β), $Ti0_2$(α)-$Si0_2$, $Zr0_2$, Al_20_3 fibers, FE and FF Al_20_3(H). It was found that $NiS0_4$-$Mo0_3$/$Zr0_2$ was a very effective low surface area catalyst, as were $NiS0_4$-$Mo0_3$ on $Ti0_2$(α) and $Ti0_2$(β). However, the high surface area $NiS0_4$-$Mo0_3$/Al_20_3(FF) had the highest activity overall, quite similar to $Ni0$-$Mo0_3$/Al_20_3 HT-100 from Harshaw. The most significant points are, however: (1) we have prepared some low surface catalysts that approach the high surface catalysts in overall activity, (2) no correlations with catalyst acid amount were found (3) optimum reaction conditions have been established, and (4) properties of the liquid fuels produced have been studied yielding promising results (may be excellent liquid fuels).

TITLE:

Production of Clean Liquid Fuels from Lignite: Catalytic Hydrotreating of Solvent Refined Lignite Employing Low Surface Area Catalysts and Commercial Catalysts

AUTHOR:

K.J. Klabunde, D.S. Jones, D.H. Ralston, K. Tanabe, M. Gorek, V.I. Stenber, N.F. Woolsey and R.J. Baltisberger

ADDRESS:

Department of Chemistry
University of North Dakota
Grand Forks, N.D.

REFERENCE:

Technology and Use of Lignite Symposium
Grand Forks, ND May 1977 (GFERC/IC-77/1) page

SUMMARY:

A series of commercial hydrotreating catalysts normally used in the petroleum industry were tested in batch autoclave experiments under moderate pressures of hydrogen to determine which were superior for conversion of solvent refined lignite (SRL) to light distillate high quality liquid fuels. It was found that $NiO-MoO_3$ on Al_2O_3 and $CoO-MoO_2$ on Al_2O_3 (both from Harshaw) were effective in this process, giving 90 percent overall conversions, with 40 to 50 percent going to light liquids and oils. However, these catalysts have very high surface areas and were originally designed for petroleum feedstocks.

TITLE:

Coal Feeder Development Program

AUTHORS:

Lockheed Missiles and Space Co.

ADDRESS:

Sunnyvale, CA

REF:

Coal Demonstration Plant (Jan-Mar 1977)
DOE/ET-0027/1
UC-89

SUMMARY:

Lockheed Missiles and Space Company, Inc., a subsidiary of Lockheed Aircraft Corporation, is conducting a coal feeder development program under the auspices of ERDA. A need exists for this development effort because current lock hopper or slurry concepts for coal feeding are inadequate. The feeder system is a critical component of a coal conversion plant, affecting equipment and maintenance cost, plant efficiency, and down time. An improved coal feeder that is applicable to all processes using pulverized dry coal at reacter pressures up to 100 atm must be developed.

TITLE:

CO-Steam Process

AUTHOR:

Everett A. Sondreal

ADDRESS:

Grand Forks Energy Research Center
Grand Forks, North Dakota

REFERENCE:

GFERC/QTR-76/3

SUMMARY:

In-house work at GFERC on the CO-Steam liquefaction process includes laboratory scale research on chemical reaction kinetics, reactor optimization, and product characterization. Research facilities include 300-cc, 1-liter, and 1-gallon batch autoclaves, specialized equipment for hot charging and timed sampling in batch experiments, a 10-lb/hr continuous unit (under construction), low and high resolution mass spectrometers with a computerized data system, gas chromatography, liquid chromatography, UV, IR, AA, and other analytical instrumentation. In-house research at GFERC is in support of process scaleup for Western U.S. coals.

During this quarter considerable progress was made in defining analytical procedures for identifying and measuring products and reactants in the CO-Steam process. A mass spectrometric method was developed for quantitative analysis of molecular species for up to 90 pct of the lignite derived oil. Pyrolysis-elemental analysis equipment (for C, H, N, O, and S) has been received, assembled, and is being operated. Nonaqueous titration methods for phenols and amines have been reduced to practice, and an automatic titrator has been ordered. Measurement of calcium and iron in product oil was performed by atmoic absorption. Progress has also been made in the high pressure liquid chromatographic methods to isolate compound types and measure molecular weight for lignite derived samples.

Six batch autoclave runs were made with hot charging periodic sampling during the reaction. Results indicate that the conversion of lignite to tetrahydrofuan soluble material is rapid ($t_{1/2}$ = 15 minutes). Exploratory work in these runs has defined the following conditions as necessary for successful hot charging and sampling: 1) a solvent which does not separate from lignite prior to and during reaction, 2) adequate stirring, 3) charging temperature below 475°C ot prevent coking, and 4) a solvent to coal ratio of at least 3:1.

TITLE:

Production of Clean Industrial and Transportation Fuels from Coal

AUTHOR:

The Lummus Company

ADDRESS:

Bloomfield, NJ

REF:

Coal Liquefaction (Jan-Mar 1977)
DOE/ET-0026/1
UC-90D

SUMMARY:

The Lummus Clean Fuel From Coal (CFFC) Process is being studied under this contract for the purpose of establishing optimum operating conditions and proving the reliability of the process. The primary objectives of this development program are to:

Establish recycle oil self-sufficiency, catalyst life, and process operability for coal liquefaction and demonstrate comparative hydroliquefaction performance of a proprietary Lummus catalyst versus a standard cobalt-molybdate catalyst.

Convert all-distillate coal liquid product to gasoline by continuous fixed-bed hydrotesting/hydrocracking operation.

Provide a preliminary engineering design of a Lummus CFFC pilot plant facility.

TITLE:

Coal Technology - Actions and Plans

AUTHOR:

G. Alex Mills

ADDRESS:

Energy Research and Development Administration

REFERENCE:

Proceedings of the 2nd Energy Technology Conference Energy Technology II
page 23) 1975

SUMMARY:

Coal, because of its abundant supply in the United States, offers a unique opportunity for both near- and mid-term supply. Unlike other energy sources such as solar and geothermal, coal offers a relatively immediately available energy supply. Moreover, an extensive technological background exists for coal extending over many decades. Coal research efforts have been greatly expanded recently. Coal technology is moving into a new, advanced phase in which laboratory findings are being tested in several large pilot plants and definitive plans and commitments being made for commercial-sized demonstration plant.

The primary objective of coal liquefaction research is to provide technology which is economically feasible and environmentally satisfactory to convert coal to a clean liquid fuel for electric power generation, transportation, and heating for industry and houses. The short term strategy is to develop to an industrial scale the conversion of coal into a low-sulfur, low-ash fuel oil suitable for electric power generation. This will release for other uses petroleum and natural gas. The longer term objective is to develop technology for production of gasoline, methanol, diesel fuel, and heating oil and chemical feedstocks.

TITLE:

R & D Engineering Services - Carbonization of Residue

REFERENCE:

Coal Liquefaction, Quarterly Report from the Office of Fossil Energy. April-June 1976, Energy Research and Development Administration, 20 Massachusetts Avenue N.W., Washington D.C. 20545

SUMMARY:

The Oak Ridge National Laboratory (ORNL) is conducting several research and development projects in support of the increased utilization of coal as a source of clean energy. Under this contract, begun in November of 1975, ORNL is to:

Review the experience with the low-temperature carbonizer at the Cresap Test Facility.

Modify the existing atmospheric batch reactor to operate continuously on solids-laden residue from ERDA processes.

Operate the above reactor with material from the H-Coal, Solvent Refined Coal (SRC), and Consol Synthetic Fuel (CSF) processes.

TITLE:

R & D Engineering Services -- Carbonization of Residue

AUTHOR:

Oak Ridge National Laboratory

ADDRESS:

Oak Ridge, TN

REF:

Coal Liquefaction (Jan-Mar 1977)

SUMMARY:

In the process, used by ORNL, the residual materials are converted to char by carbonization. The feed-stock is transported from the feed pot to the reactor by a stream of inert gas. Additional inert gas is preheated and fed to the reactor for fluidization. The fluidized-bed reactor is operated at temperatures up to 1,200°F. The char overflow pot connected to the reactor by two overflow tubes. Inert gas passing up through the central draft tube transfers the product char from the reactor to a cyclone where the gas and solid phases are separated. The gaseous effluent is subsequently scrubbed and filtered prior to being discharged.

TITLE:

R & D Engineering Services -- Hydrocarbonization

AUTHOR:

Oak Ridge National Laboratory

ADDRESS:

Oak Ridge, TN

REF:

Coal Liquefaction (Jan-Mar 1977)
DOE-ET-0026/1
UC-90D

SUMMARY:

Hydrocarbonization is an improtant type of coal liquefaction process which combines high-temperature, high-pressure, and fluidized-bed operation using hydrogen-rich gas for fluization. The hydrocarbonization process can produce controlled yields of desulfurized char, liquid fuels, and substitute natural gas. The product char may be suitable for use in boilers, without stack gas treatment units. The liquid products may be composed of naphtha, light gas oil, and heavy gas oil.

TITLE:

Flash Pyrolysis Coal Liquefaction Process

AUTHOR:

Occidental Research Corporation

ADDRESS:

LaVerne, CA

REF.

Coal Liquefaction (Jan-Mar 1977)
DOE/ET-0026/1
UC-90D

SUMMARY:

The Occidental Research Corporation (ORC), will evaluate the commercial potential of its flash pyrolysis coal liquefaction process under the sponsorship of ERDA.

The main objectives of the program are to: Demonstrate that caking coals can be processed continuously in a specially designed single-stage pyrolysis reactor without oxidative pretretement, and that this method will results in a significantly higher yield of liquids that other proposed pyrolysis processes.

Conduct extended runs in the three-ton-per-day process development unit (PDU) in order to obtain steady state heat and material balances.

Produce and recover large quantities of the primary tar, and to evaluate methods for upgrading this material to clean fuel or synthetic crude oil.

Continue development of specific areas of the pyrolysis and liquids collection systems to ensure a technologically sound basis for futher scale-up.

Obtain sufficient process and environmental data for detailed design of a larger plant and conduct an assessment of the potential commercial viability of the process.

TITLE:

Environmental Factors in Coal Liquefaction Plant

AUTHOR:

J.B. O'Hare, S.N. Rippes, B.I. Loran, W.J. Mindheinm

ADDRESS:

Ralph M. Parsons Co.
Pasadena, Calif.

REFERENCE:

CA 84 (12) 079005 EPA 650-2-74-118 1974

SUMMARY:

Environmental factors will play an important role in the design and operation of coal liquefaction plants. Such plants are a major national goal. The first large units could be built during this decade. Proposed treatment methods are discussed for solid, liquid, and gaseous effluents based on a preliminary liquefaction plant design developed for the Office of Coal Research by The Ralph M. Parsons Company. An approach to noise control procedures designed to satisfy requirements of the Occupational Health and Safety Act is also described.

During the course of future development efforts, further research is recommended to develop additional data and information on environmental factors. Such data will further improve the effectiveness and economy of plant environmental control and of the monitoring systems.

TITLE:

Hydrodesulfurization in the Solvent Refined Coal Process

AUTHOR:

W.S. Pitts, A.R. Tarrer, J.A. Guin, J.W. Prather

ADDRESS:

Coal Conversion Laboratory, Auburn University, Auburn, AL 36830

REFERENCE:

Am. Chem. Soc., Division of Fuel Chem., Preprints, 22 (2), 214 (1977).

SUMMARY:

In the present work, an experimental evaluation is made of the feasibility for accelerating HDS of coal by simply varying reaction conditions and utilizing coal mineral matter and/or other cheap regenerable catalysts. The rate data reported were all obtained in a batch system; and except for one series of experiments, only one coal type, a bituminous Kentucky No. 9/14, was used. A reaction model was developed that gives an excellent fit to the experimental data. The model, as well as other results of the comparative studies performed, is intended to assist in predicting and interpreting results from pilot studies of the SRC process, such as those at Wilsonville, Alabama, and Tacoma, Washington. The model provides also a useful design tool; but, for a reaction system as complex as the one dealt with here, it would be presumptuous to suggest that it represents the true mechanism.

In a previously reported catalyst screening study, several minerals indigenous to coal were shown to have a catalytic effect on the HDS of creosote oil. Of particular interest was the observation that in the presence of reduced metallic iron the HDS rate of the oil was significantly higher than that resulting when no mineral was present; whereas, in the presence of pyrite the HDS rate was about the same as it was when no mineral was present. These observations were surprising in that both reduced iron and pyrite are converted into the sulfide form (pyrrhotite) within the first fifteen to twenty minutes of reaction. Based on these observations, to further examine the practicality of coal mineral catalysis, a series of experiments was performed to ascertain whether the acceleration of the HDS rate in the presence of iron was predominantly thermodynamic or catalytic in nature. It is possible that iron, by removing H_2S, promotes HDS by Le Chatelier's principle, or simply prevents the H_2S from reducing the activity of catalytic sulfides by preferential adsorption.

TITLE;

Solvent-Refined Coal (SRC) Process

AUTHOR:

The Pittsburgh and Midway Coal Mining Company

ADDRESS:

Merriam, Kansas

RE:

Coal Liquefaction (Jan-Mar 1977)
DOE/ET-0026/1
UC-90D

SUMMARY:

The SRC process is being developed by Pittsburg and Midway Coal Mining Company (P&M), a subsidiary of Gulf Oil Corporation, under the sponsorship of ERDA. The specific objectives of the contract are to (1) continue obtaining technical and economic data from the pilot plant to validate scale-up to commercial production and (2) provide large samples of solvent-refined coal and by-products from the process for market development studies.

TITLE:

Comparative Economics for the Authur D. Little Extractive Coking Process

AUTHOR:

S.A. Rever, R.M. Nadkarni, R.W. Hyde, and A.H. Schutte

ADDRESS:

Arthur D. Little, Inc., 20 Acorn Park, Cambridge, MA

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering Conference Proceedings 1976 Vol I.

SUMMARY:

There is considerable interest in coal liquefaction as a means of upgrading coal to more desirable feedstocks or a more valuable fuel form. However, there are several unanswered technical issues concerning coal liquefaction, the most serious technical problems being connected with separating the liquids from the unreacted coal and ash. The Arthur D. Little (ADL) coal liquefaction process uses coking to effect a clean separation. Other advantages include efficient hydrogen utilization, low-severity extraction and coking conditions, the absence of a need for mechanical separations equipment, utilization of commercially available hardware, the absence of an extraction catalyst, and the avoidance of high-pressure slurry letdown. The process is now undergoing development under ERDA sponsorship and in in conjunction with Foster Wheeler Energy Corporation, where pilot plant testing is being carried out and Pittsburgh Energy Research Center, where solvent hydrotreating and autoclave experimentation have been done.

TITLE:

Liquefaction of Coal by Direct Hydrogenation

AUTHOR:

Rocketdyne Division
Rockwell International Corporation

ADDRESS:

Conoga Park, CA

REF:

Coal Liquefaction (Jan-Mar 1977)
(DOE/ET-0026/1
UC-90D

SUMMARY:

Under contract to ERDA, The Rocketdyne Division of Rockewell International is conducting a research program to develop a technology to liquefy coal via direct hydrogenation. This technique would involve rapid mixing, reaction, and quenching of a gaseous hydrogen and pulverized coal mixture to form hydrocarbon liquids. These products would be suitable for conversiton to fuel oil or chemical feedstocks.

TITLE:

Isopropyl Alcohol as a Coal Liquefaction Agent

AUTHOR:

David S. Ross and James E. Blessing

ADDRESS:

Stanford Research Institute, Menlo Park, CA 94025

REFERENCE:

Am. Chem. Soc., Division of Fuel Chem. Preprints, 22 (2), 208 (1977)

SUMMARY:

The use of Tetralin and similar H-donor solvents in the hydroconversion of coal to liquid fuels is well known, and is important in large-scale coal conversion processes. This report presents evidence that isopropyl alcohol can act as an H-donor solvent, yielding products similar to those generated in Tetralin-based systems. Contrary to the case for Tetralin, it appears that the action of the isopropyl alcohol can be promoted by the presence of bases. This report presents initial data from a research program still in progress; a full account of the work is to be presented in a subsequent manuscript.

TITLE:

Composition of Coal Liquefaction Products

AUTHOR:

Joseph E. Schiller

ADDRESS:

Grand Forks Energy Research Center, Grand Forks, ND

REFERENCE:

Hydrocarbon Processing, January 1977

SUMMARY:

Solvent refining of coal and coal liquefaction involve reaction of a coal/oil slurry with reducing gas (H_2 or synthesis filtration solvent) which is removed by vacuum distillation to leave solid "solvent refined" coal (SRC). In coal liquefaction, higher temperature and pressure or a catalyst are used, and some of the product oil is recycled as vehicle for continuous operation.

Five SRCs, their respective process solvents and two coal liquefaction products were analyzed by microdistillation, column chromatography, high pressure liquid chromatography and mass spectrometry. The SRCs contained from 2 to 17% volatile material (at 250°C and 1 torr), and total saturates plus aromatics ranged from 2 to 20% of the total sample. Mass spectrometric analysis of the SRC distillates showed them to be mainly unremoved solvent and solvent heavy ends. One solvent refining process studied gives a product low in ash and sulfur with very low solvent residue and minimum chemical modification of the original coal. Recycle solvents are typically 10% saturates, 60% aromatics, 10% N compounds and 20% O compounds. Vigorous hydrogenation leads to a decrease in N compounds and an increase in O compounds in the recycle solvents were the aromatics are almost entirely naphthalene and biphenyl derivatives. Coal liquefaction products from the Synthoil and CO-Steam process are midway in character between SRC and recycle solvents. These materials are 55 to 65% distillable, and the distillate contains aromatics, O compounds and N compounds in the approximate ratio of 3:2:1.

Results show that process variables have the following effects on conversion products:

·Vigorous hydrogenation of coal increases the amount of oxygen compounds and decreases the amount of nitrogen compounds in distillable products.

·Mild hydrogenation gives dibenzofuran as the major oxygenated compound, while mainly hydroxyl compounds result from vigorous hydrogenation.

·Naphthalenes and phenanthrenes are the major aromatics from mild hydrogenation, but acenaphthene/biphenyl are more abundant in vigorous hydrogenation distillates.

·Unremoved solvent or 2 and 4 condensed ring aromatics account for the major amount of distillable material in SCR.

Coal Liquefaction Plants

·The distillate from SRC #115R contains the intermediate between asphaltenes and oil in coal hydrogenation.

·Carbazoles are more unreactive than other nitrogen compounds.

·The average molecular weight of SRC is reduced by vigoroous reaction conditions.

·Aromatics in coal conversion distillates exhibit a low degree of alklyation.

TITLE:

A Simple Separation Method for Coal-Derive Solids and Heavy Liquids

AUTHOR:

Joseph E. Schiller and Dennis R. Mathiason

ADDRESS:

Grand Forks Energy Research Center, Grand Forks, ND 58202

SUMMARY:

A rapid, simple chromatographic procedure has been developed to fractionate coal-derived solids and liquids for subsequent analysis by mass spectrometry and other spectral methods. The sample is pre-adsorbed on neutral alumina (activity I), and eluted with hexane, toluene, chloroform (2 fractions) and 9:1 tetrahydrofuran-ethanol. The principal compound types eluted in each fraction, respectively, are: saturated hydrocarbons, aromatic hydrocarbons and benzofurans, ethers, nitrogen compounds, and hydroxyl compounds. Solvents and adsorbents are used as received, gravity flow columns are used, the separation may be followed visually, and less than two hours are required per analysis when several samples are separated concurrently. Mass spectral analysis is enhanced because the toluene eluate contains only aromatic hydrocarbons and ethers, while the second chloroform fraction includes almost all of the nitrogen compounds in the sample.

TITLE:

Process Development of Lignite Liquefaction

AUTHOR:

D.E. Severson, A.M. Souby and J.J. Harris

ADDRESS:

Grand Forks, ND

REFERENCE:

Proceedings of the Lignite Symposium; May 18-19, 1977; Grand Forks, ND

SUMMARY:

Primary effort of this group has been directed toward operation of a 0.6 ton/day process development unit (PDU) designed for continuous solvent extraction of lignite at pressures up to 2500 psig and at temperatures up to 950°F in an atmosphere of reducing gases, usually synthesis gas, and with a hydrogen donor solvent. The PDU features provision of recovery and recycle of solvent and of unreacted process gases. Ash removal is accomplished by dilution of vacuum flash bottoms with toluene followed by settling out and separation of the mineral matter and unreacted lignite from the toluene extract. SRL is recovered after flashing off the toluene for recycle. This report will discuss additional laboratory work, design and operational details of the PDU, effects of operating variables on yields, product characteristics, and the economics of a commercial SRL installation.

TITLE:

Process Development of Lignite Liquefaction

AUTHOR:

D.E. Severson, A.M. Souby and J.J. Harris

ADDRESS:

Project Lignite
University of North Dakota
Grand Forks, ND

REFERENCE:

Technology and Use of Lignite Symposium
Grand Forks, ND May 1977 (GFERC/IC-77/1) page 159

SUMMARY:

Progress on an ERDA-sponsored program for production of solvent-refined lignite (SRL) in an continuous process development unit (PDU) and in laboratory-batch autoclaves is reviewed. Laboratory studies discussed include investigation of process variables such as solvent type and recycle, prior storage, drying, carbonization, combustion of hydrogenation atmosphere, lignite source, and particle size of lignite. The unit has been operated from 1500 to 2500 psi, with lignite feed rates of 14 to 61 lb/hr and with solvent-to-lignite ratios of 1.33 to 3.00. Effects of pressure, temperature, and feed gas composition are presented.

TITLE:

Spectral Studies of Coal-Derived Liquids

AUTHORS:

A. J. Sharkey, Jr., H. L. Retocfsky, Fred R. Brown

ADDRESS:

Pittsburgh Energy Research Center
Pittsburgh, PA

REF:

PERC/RI-77-14

SUMMARY:

Coal-derived materials form the PERC/ERDA SYNTHOIL process have been studied with an array of spectrometric techniques. Spectral measurements are reported for the process feed coal, the total centrifuged liquid product (CLP) and 13 fractions derived from the CLP. Mass spectrometry, magnetic resonance and infrared spectroscopy were the primary instrumental techniques utilized.

TITLE:

CO-Steam Process

AUTHOR:

Everett A. Sondreal

ADDRESS:

Grand Forks Energy Research Center, ERDA
Grand Forks, ND

SUMMARY:

The major objective to develop engineering design data for commercialization of the CO-Steam coal-liquefaction process for producing liquid fuels of suitably low sulfur, nitrogen and ash contents from low-rank Western Coals to be environmentally satisfactory. To obtain laboratory data for optimization of reactor design. To cooperate with the Pittsburgh Energy Research Center in planning, design, construction, and operating of a process development unit (PDU) at Grand Forks under contract with selected outside organizations. To establish an analytical support capability in product characterization for both laboratory and PDU programs.

TITLE:

Neutron Activation Analysis at the Livermore Pool-Type Reactor for the Environmental Research Program

AUTHOR:

R.C. Ragaini, R.E. Heft, and D. Garvis

ADDRESS:

Lawrence Livermore Laboratory
University of California, Livermore, CA 94550

REFERENCE:

Distribution Category UC-11, UCRL-59092

SUMMARY:

Instrumental neutron activation analysis is a technique of trace analysis using measurements of radioactivity induced in the sample by exposure to a source of neutrons. The induced activity is measured by the energy of the photopeaks produced as the nuclide decays and by the half-life of the neutron-induced activity. A complex computer program GAMANAL has been used to accomplish the major tasks of nuclide identification and quantification. The nuclide data output from GAMANAL is processed by a second computer code NADAC, which develops elemental abundance data from disintegration rates observed. The methods are those employed at the Livermore Pool-Type Reactor in support of the Environmental Research Program. Among the procedures described and discussed are sample preparation, irradiation, analysis, and application of the technique.

TITLE:

Organic Contaminants in Aqueous Coal Conversion Effluents: Environmental Consequences and Research Priorities

AUTHOR:

Stephen E. Harbes, Carl W. Gehrs, George R. Southworth

ADDRESS:

Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge,
Tn 37830

REFERENCE:

Publication No. 880, Environmental Sciences Division, ORNL

SUMMARY:

The anticipated emplementation of an extensive coal conversion industry in the United States within several decades will result in production of substantial quantities of highly-contaminated wastewater. Many of the contaminants produced, if released into natural waters, could have deleterious effects on aquatic ecosystems, and ultimately, on human life. Research is required to determine potential acute and sub-acute effects of potentially hazardous effluents constituents, and to evaluate their transport and persistence in aquatic systems.

To facilitate a rational assignment of future aquatic research priorities to answer these issues, we have initiated a systematic assessment of the environmental hazards of anticipated organic components of aqueous coal liquefaction effluents by the compilation of a critical literature review. Five major classes of organic compounds have been operationally defined: (1) phenols, (2) arylamines (organic bases), (3) aliphatic hydrocarbons, (4) mono- and polycyclic aromatic hydrocarbons (PAH), and (5) sulfur-containing compounds. We present here a summary assessment of each class on the basis of (1) concentrations anticipated in coal liquefaction effluents, (2) removal by wastewater treatment systems, (3) acute toxicity, (4) chronic toxic effects on aquatic organisms, and (5) environmental transport and persistence. Gaps in understanding and future research needs are identified.

Coal Liquefaction Plants

TITLE:

Organic Sulfur Compounds in Coal Hydrogenation Products

AUTHOR:

Sayeed Akhtar, A. G. Sharkey, Jr., J.L. Shultz, and P.M. Yarrersky

ADDRESS:

U.S. Department of the Interior, Bureau of Mines, 4800 Forbes Avenue,
Pittsburgh, Penn. 15213

REFERENCE:

Paper presented at 167th National Meeting, Am. Chem. Soc., March 31 - April 5, 1974

SUMMARY:

Bituminous coals from Indiana #5 seam and Homestead mine, Kentucky, were hydrogenated in a batch autoclave at 450°C and 4,000 psi without adding any catalyst. In one hour more than 90 percent of the coals were converted to benzene soluble liquids and gases. The liquid products contained 14 organic sulfur compounds, 13 of them thiophene derivatives. Their relative ease of decomposition was determined by Dibenzothiophene is most difficult to decompose, followed by benzothiophene and naphthobenzothiophene.

TECHNICAL REPORTS:
COAL GASIFICATION PLANTS

TITLE:

Magnetic Desulfurization of Some Illinois

AUTHOR:

Haydn H. Murray

ADDRESS:

Department of Geology, Indiana University, Bloomington, Indiana 47401

REFERENCE:

American Chemical Society, Division of Fuel Chemical Preprints, 22 (2), 106 (1977).

SUMMARY:

High extraction magnetic filtration (HEMF) has long been used to successfully process kaolin for commerical use. Due to the fact that pyritic sulfur accounts for 40 to 80% of the sulfur content of most coals, HEMF can be used to desulfize coal prior to bruning. Pyritic sulfur is paramagnetic, thus it is amenable to the HEMF treatment. This paper gives the results of desulfurization tests on several coals using the HEMF technique and discusses the economics of the process.

TITLE:

Synthane Process

AUTHOR:

The Lummus Company

ADDRESS:

Bloomfield, NJ

REF:

Coal Gasification (Jan-Mar 1977) p. 21-24
DOE/ET-0024/1
UC-90C

SUMMARY:

The Synthane process was developed by the Bureau of Mines and is now the responsibility of ERDA. The government-owned Synthane pilot plant is being operated by the Lummus Company. The objective of this contract is to obtain definitive process information, sufficient for commercial design purposes, on the conversion of coal to gas of pipline quality.

TITLE:

Humans: Metabolism and Biological Effects

AUTHOR

S. S. Talmage

REF:

Environmental, Health, and Control Aspects of Coal Conversion: An Information Overview. 2, 10/1-10/89, (1977) ORNL/EIS-95

SUMMARY:

Coal conversion processes may produce and release substances that can be hazardous to human health; some substances, studies indicate, are potential carcinogens, cocarcinogens, mutagens, or teratogens. Others promote chronic respiratory and/or metabolic diseases. However, rigorous quantitative data relating human exposure with health effects are still sparse.

The effect of carcinogens can be enhanced or inhibited by associated substances. For example, particulates, sulfur dioxide, and some aliphatic hydrocarbons have been identified as possible cocarcinogens, whereas vitamin A and several antioxidants appear to give partial protection against the formation of cancers.

TITLE:

Production of Low Btu Gas Involving Coal Pyrolysis and Gasification

AUTHOR:

C.Y. Wen, R.C. Bailie, C.Y. Lin and N.S. O'Brien

ADDRESS:

Chemical Engineering Department, West Virginia University, Morgantown, W. Va.
26506

SUMMARY:

Experiments involving the pyrolysis of bituminous coal, sawdust, and other carbonaceous feed materials have been performed in a 15-inch diameter, atmospheric, fluidized bed. Data from the pyrolysis experiments are analyzed to generate kinetic and heat-transfer information and to formulate a coal pyrolysis model useful in the design of commercial-sized processes. The model is then applied in forming a conceptual flowscheme for a relatively low pressure (5-13 atm) electrical-power generation plant. In the conceptual flowscheme, the low Btu gas is produced in two units, a pyrolyzer and a pyrolysis-char gasifier. The gas is then purified and fed into a combustion chamber; the electricity is generated in an advanced design gas turbine and steam turbine power cycle.

Coal Gasification Plants

TITLE:

Activities in Support of OCR/AGA Coal Gasification Program

AUTHOR:

C.F. Braun & Company

ADDRESS:

C.F. Braun & Company
Alhambra, California 91802

REFERENCE:

FE -- 1235-T-4

SUMMARY:

Studies on acid-gas removal processes, sulfur recovery, and shift conversion have progressed to the estimating stage for comparative cost evaluation; also comparing the alternatives of coal pretreatment at high or low pressure. Studies on effluent treatment have progressed to the point where experimental data from pilot plant operation is necessary before more definitive design work can be done.

Included also are reviews on the liquid phase methanation work and the first-pass commercial concept for the synthane process.

TITLE:

Desulfurization of Low-BTU Producer Gas

REFERENCE:

Coal Gasification, Quarterly Report from the Office of Fossil Energy April-June, 1976, Energy Research and Development Administration, 20 Massachusetts Avenue N.W., Washington, D.C. 20545

SUMMARY:

Air Products and Chemicals, Inc. (APCI), under the sponsorship of ERDA, is conducting a research, development, and engineering support program to accelerate the development of a solid-absorbent system for desulfruizing hot, low-BTU producer gas. This system, being developed by ERDA at the Morgantown Energy Research Center (MERC), involves the use of a cyclic, fixed bed with iron oxide on fly ash as the absorbent, at producer gas temperatures and pressures. The specific objectives of the APCI support program are development of an iron oxide/fly ash absorbent, definition of process scale-up criteria, and process design of a commercial-size system.

TITLE:

Coal Gasification: A Review

AUTHOR:

C. R. Aleta

ADDRESS:

304 Olin Hall
Cornell University
Ithaca, NY 14850

REFERENCE:

NTIS No. PB-228 887

SUMMARY:

Methods of underground and aboveground gasification of coal are reviewed. Four promising aboveground gasification techniques--Hygas, CO_2 Acceptor Process, Bigas, and Synthane--are described and compared. The objective of these four methods is to produce synthetic pipeline gas from coal. Recent trends, however, indicate that production of natural gas from gasification of naptha feedstocks is likely to become commercialized earlier than production by gasification of coal.

The environmental effects of fuel gasification of coal to supplement the deficiency of natural gas by the 1990's is discussed in the appendix.

TITLE:

Solvent Coal (SRC) Process: Environmental Program

AUTHORS:

Alsid, Snowden and Associates

ADDRESS:

13240 Northrup Way
Bellevue, Washington 98005

REF:

FE/496-T16 (NTIS)

SUMMARY:

This report summarizes the environmental program under the Solvent Refined Coal (SRC) Contract from January 1, 1972, through June 30, 1977. Three major areas are included in the program. They are: air quality, water quality, and foliage effects. Baseline studies of air and water quality were performed before the pilot plant was constructed. Studies made during plant operation indicate that the pilot plant had virtually no measureable impact on air and water quality in the surrounding environment. Foliage studies made during plant operation at areas that would be receptors of plant emmissions and at control areas indicate that the pilot plant operation has no discernable effect upon the vegetation. Monitoring studies will continue throughout the pilot plant operation.

TITLE

High-BTU Gasification

REFERENCE:

Shaping Coal's Future through Technology, 1974-1975
Office of Coal Research, Washington, D.C. 20402
Stock #024-014-0112-2

SUMMARY:

In 1971, industry, as represented by the American Gas Association (AGA) and the Government joined together in cooperative efforts to establish a viable coal-gasification industry by means of a joint, accelerated research and development program. The principle objective of this program is the continued development of each of three different but technically feasible processes for the conversion of coal to high-BTU gas. It was determined that only concurrent development of each concept through the pilot plant stage could generate, within the shortest period of time, the data necessary to determine which of the three concepts is more suitable for implementation on a commerical scale. At the same time, the program recognized the need to develop a suitable, compatible methanation process, to investigate the suitability of current state-of-the-art gasification systems and to initiate support studies for the development of advance structural materials, sophisticated processing equipment and supporting processes.

The overall program now underway includes a large number of projects. Each project has been selected so that, through its subsequent development, data needed in the design of the many processing subcomponents contained by a complex coal-gasification facility will be generated. Depending upon the objectives to be accomplished by the data so accumulated, these projects have geen grouped together into one of the following four divisions.

A. Development of New, Sophisticated Coal-Gasification Techniques for the Production of High-BTU Gas.

B. Development of Auxiliary Process Integral to a High-BTU Coal-Gasification Plant.

C. Engineering Assessments as Required for Process Evaluation, Selection, and Design.

D. Development projects to provide needed but unavailable supporting technology.

TITLE:

Liquid Phase Methanation Process

REFERENCE:

Coal Gasification, Quarterly Report from the Office of Fossil Energy. April-June 1976, Energy Research and Development Adminstiration, 20 Massachusetts Avenue N.W., Washington, D.C. 20545

SUMMARY:

The liquid phase methanation process is being developed by Chem Systems, Inc., under the auspices of ERDA and the American Gas Association (AGA).

ERDA is providing two-thirds of the funds and AGA, one-third.

The overall objective of this contract is to develop a practical and useful process for converting coal-derived synthesis gases to methane as the major constituent of synthetic natural gas, using liquid fluidized beds.

The work is divided into three phases. The first phase was a laboratory investigation to establish the technical feasibility of methanation of synthesis gases by passing them through a liquid containing solid catalyst particles. The specific objectives were to:

Develop an acceptable process liquid (to suspend catalytic particles) and investigate the use of aromatic and paraffinic hydrocarbons as possibilities; investigate various catalytic materials that can be used in the methanation process; determine the catalyst particle size that will produce the optimum process reaction; develop a reaction correlation model for investigating the mass transfer from gas to liquid, the mass transfer from liquid to catalyst, and the catalytic surface reaction.

The second phase included the design, procurement, construction, and operation of a process development unit having a design feed gas rate of 1,500 standard cubic feet per hour. The specific operational objectives were to determine:

Catalyst life, recovery, and regeneration methods; liquid life and effectiveness, the effect of all process variables on performance; the correlation between the laboratory reaction models and process development unit performance data; data needed for engineering designs and cost estimates of large plants.

The third phase includes the design, procurement, technical supervision, and construction of a pilot plant methanation unit. The unit will be used to (1) demonstrate the liquid phase methanation process on a synthesis gas actually produced in a coal gasification process and (2) obtain data for detailed design and engineering of a methanation unit for a coal gasification plant having a capacity of about 250 million standard cubic feet per day.

TITLE:

Molten Salt Gasification Process

AUTHOR:

Atomics International Division
Rockwell International Corporation

ADDRESS:

Canoga Park, CA

REF:

Coal Gasification (Jan-Mar 1977) p. 37-46
DOE/ET-0024/1
UC-90C

SUMMARY:

The molten salt coal gasification process is being developed by the Atomics International Division of Rockwell International Corporation. This 45-month project, initiated in March 1976, is sponsored by ERDA.

The objective of this project is to demonstrate the feasibility of the molten salt coal gasification process for use in environmentally-acceptable generation of electric power. Atomics Interantional is to design and construct a process development unit (PDU) which will convert one ton of coal per hour to a non-polluting low-Btu fuel gas. The PDU will be located at the Santa Susana Test Site of Atomics International. In addition, Atomics International is to operate the plant to obtain data for evaluating the process and designing a full-scale commercial plant.

TITLE:

Symposium Proceedings: Environmental Aspects of Fuel Conversion Technology (May 1974, St. Louis, Missouri)

AUTHOR:

Franklin A. Ayer (compiler)

ADDRESS:

Research Traiangle Institute
P.O. Box 12194
Research Triangle Park, NC 27709

REFERENCE:

Pb238 304 (NTIS)

SUMMARY:

The principal objective of the symposium was to review and discuss environmentally related information of coal conversion technology. More specifically, papers were presented that covered environmental quality and standards, fuel contaminannts, environmental aspects of specific fuel conversion systems, fuel utilization and total environmental assessment, and research and development needs.

TITLE:

Agglomerating Burner Process

AUTHOR:

Battelle Memorial Institute

ADDRESS:

Columbus, OH

REF:

Coal Gasification (Jan-Mar 1977) p. 25-28
DPE/ET-0024/1
UC-90C

SUMMARY:

The agglomerating burner gasification process is being developed by Battelle Memorial Institute, under the sponsorship of ERDA. The objective of the current contract is to develop a two-stage process using a self-agglomerating fluidized-bed combustor as part of a practical and economical means for producing synthesis gas by steam gasification of coal. A process development unit is to be designed, constructed, and operated, and the following aspects of the process are to be explored:

Operability of a self-agglomerating fluidized bed coal combustor that operates on eastern bituminous coal under pressure and uses air for combustion.

Mechanical feasibility of continuous circulation of hot ash agglomerates between fluidized-bed combustor and gasifier vessels at seven atm pressure and at flow rates and temperatures required for effective heat transfer.

Operability of integrated fluidized-bed burner and gasifier vessels both fed by eastern bituminous coal (or char in the base of the combustor) and operating at seven atm pressure.

TITLE:

Respiratory Rentention Function Applied to Particle Size Distribution

AUTHOR:

A. Biermann and J. Ondov

ADDRESS:

Lawrence Livermore Laboratory, Unviersity of Californai
Livermore, California 94550

REFERENCE:

Distribution Category UC 41, UCRL-52135

SUMMARY:

Particulate amount deposited in regions of the respiratory tract are assessed by the use of a simple numerical integration of the ICRP lung deposition function with particulate size distributions. The fractional mass retained in a respiratory region, from both a number and mass particle size distribution of emitted fly ash, is calculated. Also, bimodal, nonlognormal, and mass histogram distributions are investigated with this technique.

TITLE:

Low-BTU Fuel Gas (Tri-Gas Process)

AUTHOR:

Bituminous Coal Research, Inc.

ADDRESS:

Monroeville, PA

REF:

Coal Gasification (Jan-Mar 1977)
DOE/ET-0024/1
UC-90C

SUMMARY:

Bituminous Coal Research (BCR) is developing a multiple fluidized bed coal gasification process for producing low-Btu fuel gas from caking and noncaking coals. The low-Btu fuel gas product will be suitable primarily as boiler fuel gas for electricity generation, although alteration of operating conditions could yield medium-Btu gas suitable for other uses. The research task includes the design, construction, and testing of a process development unit, and laboratroy investigations.

TITLE:

Bi-Gas Process for the Generation of Pipeline Gas

AUTHOR:

Bituminous Coal Research, Inc.

ADDRESS:

Monroeville, PA.

REF:

Coal Gasification (Jan-Mar 1977)
DOE/ET-0024/1
UC-90C

SUMMARY:

The BI-GAS process is being developed by Bituminous Coal Research, Inc. (BCR), under the auspices of ERDA and the American Gas Association (AGA) as part of the effort to develop a method for producing high-Btu pipeline gas from coal. The pilot plant operational program is being managed by Phillips Petroleum Company.

The principal objective of this program is the development of the BI-GAS process. Specifically, BCR is directed to:

Conduct laboratory-scale coal gasification experimentation, together with process and equipment development, to verify the technical and economic feasibility of producing high-Btu gas using the BI-GAS process.

Design, construct, and operate a multi-purpose research pilot plant with the aid of engineering subcontractors.

TITLE:

Low-BTU Gasification of Coal by Atomics International's Molten Salt Process

AUTHOR:

W.V. Botts, A.L. Kohl, C.A. Trilling

ADDRESS:

Atomics International Division, Rockwell International

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering Conference Proceedings
1976 Vol. I.

SUMMARY:

Research and development work conducted to date has demonstrated the basic feasibility of the Molten Salt Coal Gasification Process and indicated it to have a number of key technical advantages over other techniques for converting coal to clean gas. The design of a Process Development Unit (PDU) is well under way under ERDA sponsorship. The PDU program is aimed at demonstrating the performance of a complete integrated system and providing design data for process scale-up and evaluation. Engineering studies to evaluate the applicability of the process of power generation indicate the potential generation system appears to be combined cycle involving gasification with air under pressure, combustion of the product gas in a gas turbine, and operation of a waste heat boiler system on the turbine exhaust gas.

TITLE:

Interpretation of Chemical and Physical Measurements from an In Situ Coal Gasification Experiment

AUTHOR:

Charles F. Brandenburg, Ray P. Reed, R. Michael Boyd, David A. Northrop, and James W. Jennings

ADDRESS:

Society of Petroleum Engineers of AIME
6200 North Central Expressway
Dallas, TX 75206

REFERENCE:

Prepared for the 50th Annual Fall Meeting of the Society of Petroleum Engineers of AIME, Dallas, TX, Sept. 28-Oct. 1, 1975. Paper Number: SPE 565A

SUMMARY:

A second undergound coal gasification experiment is being conducted at the Laramie Energy Research Center's field site near Hanna, Wyoming. This paper presents the results from the first phase of the Hanna II experiment in which coal seam permeability was evaluated, pneumatic linking and linking via reverse combustion were studied, and a sustained gasification process was maintained between the two linked vertical wells. Extensive in situ and surface process instrumentation on the chemical and physical mechanisms involved in underground coal gasification were used. Air injection alone did not increase permeability to levels which would allow sustained gasification. Reverse combustion linking was determined to be a local, relatively low temperature process which advanced at a 5 ft/day rate and produced a high permeability carbonized path. Subsequent gasification was completed over a 38 day period. Overall, injection of 1.9 MM scf/day of air yielded 2.7 MM scf/day of gas with a heating value of 152 Btu/scf. Material balance calculations indicate that 1688 tons of coal in place were utilized. Specific discussion or reaction front configurations and interpretation of in situ thermometry are included.

TITLE:

Evaluation of High-BTU GAsification Projects

AUTHOR:

C. F. Braun and Company

ADDRESS:

Alhambra, CA

REF:

Coal Gasification (Jan-Mar 1977) p. 33-36
DOE/ET-0024/1
UC-90C

SUMMARY:

High-Btu gasification projects are being evaluated by the engineering firm of C.F. Braun and Company. The project, initiated in September 1972, is being sponsored by ERDA and the American Gas Association (AGA).

The overall objectives of this contract are to provide technical evaluations of gasification processes currently being investigated and develop conceptual designs for commercial plants to produce pipeline-quality gas using each of the candidate processes. These evaluations and concept designs will permit early identification of problem areas so as to develop solutions through pilot plant accelerated mechanical development programs. They will provide bases for recommending the process that should be demonstrated with commercial-size equipment. The process will be selected based on criteria such as successful demonstration in pilot plant operations, reliability, suitability for handling a variety of coals, economic viability, thermal efficiency, and significance of potential environmental impacts.

TITLE:

Physical Property Data on Fine Coal Refuse

AUTHOR:

R.A. Busch, R.R. Backer, L.A. Atkins, and C.D. Kealy

ADDRESS:

Spokane Mining Research Center, Spokane, Washington 99210

REFERENCE:

Bureau of Mines Report of Investigation (1975) I 28.23:8062

SUMMARY:

The elemental, chemical and mineral compositions of some representative coal sludges as determined by x-ray diffraction and other spectrographic methods is given. A discussion of coal sludge deposits and the undesirable characteristics of the sludge which make these deposits potentially dangerous is given. Some possible alternatives to dumping of this refuse are offered, in particular recovery of burnable coal, high grade alumina precursors, and other valuable by products.

TITLE:

Trace Element Leaching from Ash and Scrubber Sludge at Five Generating Stations

AUTHOR:

S. Carlisle, J. Norris and A. Weir, Jr., Southern California
Edison Company
F. Mesich and W.F. Holland, Radian Corporation

ADDRESS:

Southern California Edison Company
B800, 2244 Walnut Grove Avenue
Rosemead, California 91770

REFERENCE:

Presented at the twelfth Air Pollution and Industrial Hygiene Conference
"Air Quality Management in the Electric Power Industry"
Austin, Texas, January 28-30, 1976

SUMMARY:

The disposal of solid wastes from coal-fired electric generating stations was investigated from the standpoint of potential trace element contamination of ground waters. Coal ash and lime/limestone flue gas desulfurization sludge are commonly disposed of by ponding. The trace elements entering the generating station in the coal will leave the station primarily in the ash and sludge. Contact with water in a disposal pond will solubilize a small amount of the trace elements and, if pond leakage occurs, a potential problem with ground-water contaimination could be of concern.

Actual samples of ash and sludge from five operating generating stations were mixed with water to simulate ponding. The levels of the dissolved trace elements were in general very low, near the analytical detection limit. As an example, the trace element levels in the supernatant of many ponds are comparable to those found in make up waters for the generating stations.

Results of soil leaching tests have shown that the soil underlying a pond has the ability to remove trace elements from any pond leakage. Thus, even in cases where the concentration of an element may be higher than desirable, groundwaters can be protected from contamination.

TITLE:

Plant Interaction

AUTHOR:

R. F. Carrier

REF:

Environmental, Health and Control Aspects of Coal Conversion: An Information Overview. 2, 8/1-8/100, (1977) ORNL/EIS-95

SUMMARY:

Plants affect man in many ways: They are part of his diet, his aesthetic environment, and his economic situtation; they form the basis of the environmental food chain, and they play a role in the cycling of atmospheric and aquatic pollutants. Therefore, knowledge of plant-pollutant interactions is essential for evaluating possible environmental and health effects of potential industrial effluents.

The chemical pollutants from coal conversion processes have not yet been completely characterized. Nevertheless, sufficient information about effluents from similar industries is available to allow preliminary examination of their interaction with plants.

It is not the intent of this chapter to include every published aspect of plant interactions with the potential pollutants from a coal conversion industry. Rather, the aim has been to give some indication of the areas in which abundant material is available and to highlight areas of potential interest and concern.

TITLE:

Liquid Phase Methanation Process

AUTHOR:

Chem System, Inc.

ADDRESS:

Hackensack, NJ

REF:

Coal Gasification (Jan-Mar 1977) p. 29-32
DOE/ET-0024/1
UC-90C

SUMMARY:

The liquid phase methanation process is being developed by Chem Systems, Inc., under the auspices of ERDA and the American Gas Association.

The overall objective of this contract is to develop a practical and useful process for converting coal-derived synthesis gases to methane as the major constitutent of synthetic natural gas, using liquid fluidized beds.

The work is divided into three phases. The first phase is a laboratory investigation to establish the technical feasibility of methanation of synthesis gases by passing them through a liquid containing solid catalyst particles.

The second phase includes the design, procurement, construction, and operation of a process development unit having a design feed gas rate of 1,500 standard cubic feet per hour.

The third phase includes the design, procurement, technical supervision, and construction of a pilot plant methanation unit.

TITLE:

Low-Btu Gasification of Coal for Electricity Generation

AUTHOR:

Combustion Engineering, Inc.

ADDRESS:

Windsor, CT.

REF:

Coal Gasification (Jan-Mar 1977) p. 45-48
DOE/ET-0024/1
UC-90C

SUMMARY:

A method for the production of low-Btu gas from coal for electricity generation is being developed by Combustion Engineering, Inc., under the sponsorship of ERDA and an industry team.
The overall objective of this contract is to generate electricity economically from a low-Btu coal gas in an environmentally acceptable manner, with a minimum of process development. Combustion Engineering is conducting a three-phase program involving the design, construction, and operation of a coal gasification process development unit.

TITLE:

Carbon Dioxide Acceptor Coal Gasification Process

AUTHOR:

Conoco Coal Development Company

ADDRESS:

Library, PA.

REF:

Coal Gasification (Jan-Mar 1977) p. 5-8
DOE/ET-0024/1
UC-90C

SUMMARY:

The carbon dioxide acceptor process is being developed by the Conoco Coal Development Company (CCDC) under the joint sponsorship of ERDA and the American Gas Association (AGA).

The objectives of this contract are to (1) demonstrate the operability of all features of the carbon dioxide acceptor process through operation of a pilot plant and (2) obtain adequate design data to construct a commercial plant capable of producing 250 million standard cubic feet of high-Btu gas per day. Specifically, CCDC is to:

Test several types of lignite and acceptors.

Design, construct, and operate methanation facilities in conjunction with the gasification pilot plant.

Use process data derived from pilot plant runs to improve the process.

TITLE:

Current Status of Studies in Slagging Fixed-Bed Gasification

AUTHOR:

Robert C. Ellman, Bruce C. Johnson, Harold H. Schobert, Leland E. Paulson, and M. Merle Fegley

ADDRESS:

U.S. ERDA Grand Forks Energy Research Center, Grand Forks, ND

REFERENCE:

Technology and Use of Lignite Symposium
Grand Forks, ND (May, 1977) GFERC/IC-77/1 (page 207)

SUMMARY:

Recent accomplishments and status of a research program to study slagging fixed-bed gasification of a variety of coals and the characteristics and properties of effluents produced are discussed. The operability of a pilot plant which was in standby status for over ten years was re-established in May of 1976. Test results accumulated to date in the reactivated pilot plant using lignite from the North American Mine of Zap, N. Dakota are presented. Initial tests were directed to re-establish operability, train operating personnel, and develop sampling and operational reproducibility, refine analytical techniques for effluent characterization, improve refractory life, and establish controlled test conditions for comparative studies.

TITLE:

Current Status of Studies in Slagging Fixed-Bed Gasification at the Grand Forks Energy Research Center

AUTHUR:

R.C. Ellman, B.C. Johnson, H.H. Schobert, L.E. Paulson, and M.M. Fegley

ADDRESS:

Grand Forks Enerfy Research Center, Energy Research and Development Administration, Grand Forks, North Dakota

REFERENCE:

Preprints of the 9th Biennial Lignite Symposium, Grand Forks, North Dakota

SUMMARY:

The recent high level of interest in slagging fixed-bed gasification indicates that it may well be the process utilized in second generation gasifiers. This paper has been prepared to describe the process facilities and current status of a reactivated research program in the only existing slagging fixed-bed gasification pilot plant in the United States. The research program includes operational studies, slag and refractory studies, and effluent collection and analysis. Each of the three areas is discussed separately in this paper. A description of the gasifier design and configureation is provided.

TITLE:

Slagging Fixed-Bed Gasification at the Grand Forks Energy Research Center

AUTHOR:

Robert C. Ellman and Bruce C. Johnson

ADDRESS:

Grand Forks Enerfy Research Center

REFERENCE:

Eight Synthetic Pipeline Gas Symposium, ERDA

SUMMARY:

The recent high level of interest in slagging fixed-bed gasification as evidenced by the studies at Westfield, Scotland and the selection by ERDA of this process for a demonstration plant, indicates that this may be the process of choice for second generation gasifiers. This brief summary has been prepared to describe pilot plant facilities and capabilities of the only existing slagging fixed bed gasification pilot plant in the United States. In addition the objectives of the slagging gasification research program which was reestablished in 1974 at the Grand Forks Research Center of ERDA are presented.

The slagging gasification pilot plant was first designed and operated under the Bureau of Mines, Dept. of Interior, during the period 1958 to 1965 to determine the feasibility of slagging operation and to assess operational parameters. From 1965 until 1974 the pilot plant was essentially maintained in a moth-ball status. Operation of the GRERC gasifier was resumed in May of 1976 after reconditioning the unit and installing a new oxygen supply system. To date, the resumed operations have been primarily directed at training operating personnel, developing sampling and analytical procedures, and establishing reproducibility in operating data.

TITLE:

Slagging, Fixed-Bed Gasification

AUTHOR:

Robert C. Ellman

ADDRESS:

Grand Forks Energy Research Center, Grand Forks, N.Dakota

REFERENCE:

GFERC/QTR - 76/3 UC-90

SUMMARY:

A pilot-scale pressure fixed-bed slagging gasifier constructed and operated at GFERC in the period 1958 to 1965, is being reconditioned for further studies. Resumed operation is scheduled for the latter part of FY 1976. Since 1965, the gasification unit has not been used, with some system components disassembled and some instrumentation utilized in other projects. Major components, however, has been retained in a moth-ball status.

Previous studies (1958-65) had been directed to establish operability of the slagging method of ash discharge and to evaluate process parameters. These studies demonstrated that the slagging ash-removal mode of operation increased gas production capacity fourfold and reduced steam consumption by a factor of five, compared to dry ash-removal operation.

A major objective of the present program is to produce liquid effluents for study. The quantity and properties of effluents produced in fixed-bed gasification of a variety of Western coals and chars will be studied by which recovery of useable products will be maximized, environmentally undersirable water will be achieved. It is believed that the character and composition of effluents produced in the slagging gasifier will be closely comparable to those produced in the dry-ash type. Data and information should, therefore, be directly application to environmental considerations in respect to the first-generation coal-based synthetic natural gas plants now being planned by industry.

Coal Gasification Plants

TITLE:

Catalytic Coal Gasification for SNG Production

AUTHOR:

W.R. Epperly, H.M. Siegel

ADDRESS:

Exxon Research and Engineering Company

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering Conference Proceedings
1976 Volume I

SUMMARY:

Exxon Research and Engineering Company is engaged in the early stages of research and development on a catalytic coal gasification process for the production of substitute natural gas (SNG). The catalyst, which is an alkali carbonate, increases the rate of steam gasification, prevents agglomeration when gasifying caking coals, and promotes gas phase methanation equilibrium. The processing sequence which is being studied maximizes the benefits which can be derived from use of the catalyst. The process combines a relatively low gasifier temperature of 1200-1400°F (650-750°C) with separation of synthesis gas (CO + H2) from the product methane and recycle of the synthesis gas to the gasifier. Thus the only net products from gasification are CH_4, CO_2, and small quantities of H_2S and NH_3 and the overall gasification step is essentially thermoneutral. By contrast with thermal processes, the catalytic process requires very little high level heat input and, in addition, synthesis gas shift conversion and methanation are unnecessary. As a result, the catalytic process potentially is higher in thermal efficiency and lower in cost than existing thermal coal gasification processes.

TITLE:

Coal Gasification

AUTHOR:

ERDA

ADDRESS:

Pittsburgh Energy Research Center
4800 Forbes Avenue
Pittsburgh, PA 15213

REF:

Clean Energy form Coal (p. 11-13)
PERC 1000

SUMMARY:

PERC is conducting research and development on two processes designed to produce substitute natural gas (SNG) from coal. The SYNTHANE processes under development elsewhere, for recommendation by ERDA to industry for ultimate commercialization. Another process under study at PERC appears to have certain advantages of even simpler, more efficient operation that will be explored for possible input into ERDA's general gasification program.

TITLE:

Chemical from Coal

AUTHOR:

ERDA

ADDRESS:

Pittsburg Energy Research Center
4800 Forbes Avenue
Pitsburg, PA 15213

REF:

Clean Energy from Coal (p. 19)
PERC 1000

SUMMARY:

Projections of demand for C_2-C_4 olefins in the U.S. during the next decade indicate that a two-fold expansion in manufacturing capacity will be necessary. This new capacity will be based primarily on cracking heavier feed-stocks, such as naphtha or gas oil derived from coal. Besides these olefins, which are valuable as basic chemicals for the manufacture of plastics and rubber, the paraffinic C_2-C_3 hydrocarbons are valuable as high-Btu supplements for pipeline gas. Any excess of propane or butane will find its way to market via liquefied petroleum gas. Alcohols and hydrocarbons of somewhat higher molecular weight can be used as gasoline blending stocks or cracked to gaseous hydrocarbons.

TITLE:

The Laramie Energy Research Center's Underground Coal Gasification Program

AUTHOR:

ERDA

ADDRESS:

Laramie Energy Research Center, Energy Research & Development Adminsitration,
Laramie, WY

REFERENCE:

May-June 1977

SUMMARY:

A series of underground coal gasification (UCG) field tests have been conducted since 1972 at a site near Hanna, Wyoming, with the most recent, Hanna 11, having been completed in July 1976. Results exceeded predicitions based on previous tests at Hanna. Maximum gas production achieved was 11.5 MM scf/day (million standard cubic feet/day) with a heating value of 175 Btu/scf (equivalent to 325 barrels of oil per day). Over 6700 tons of coal were gasified during the test. The technique being developed at Hanna, by ERDA scientists at the Laramie Energy Research Center, is known as the Linked Vertical Well (LVW) concept.

TITLE:

Status of the Linked Vertical Well Process

AUTHOR:

D.D. Fischer,* C.F. Brandenbrug,* S.B. King,* R.M. Boyd,* and H.L. Hutchinson**

ADDRESS:

*ERDA, Laramie Energy Research Center, Laramie, WY
**University of Wyoming and ERDA, Laramie Energy Research Center, Laramie, WY 82071

SUMMARY:

The Linked Vertical Well (LVW) process, which employs reverse combustion as a preparatory step to forward combustion gasification, will be described from both a practical and theoretical viewpoint. Fifty years of underground coal gasification experimentation has shown that, prior to efficient gasification, a "linkage" between injection and production boreholes must be prepared. The LERC experimentation has concentrated on the characterization and the development of reverse combustion linking such that it has become a predictable means of process control. The results of eight different reverse combustion links at Hanna indicate that subbituminous coal is ideally suited to reverse combustion linkage both from a controllability standpoint and the quantity of air needed to complete a linkage. Following reverse combustion linking, forward gasification ensues. Eight different well to well gasification periods have been completed since initiation of tests at Hanna. A detailed chemical and physical description of the recent results from Hanna II will be given. This latter experiment resulted in the gasification of 6690 (6070 tons) of coal and production of up to 12 MM scfd (0.36 MM scmd) of 175 Btu/scf (6.2 metajoules/scm) gas. The reasons for these improved process results will be discussed in detail.

TITLE:

Soze-Dependence of the Physical and Chemical Properties of Coal Fly Ash*

AUTHOR:

G.L. Fisher, B.A. Prentice, D. Silberman, J.M. Ondov, R C. Ragaini, A.H. Bierman, A.R. McFarland, and J.B. Pawley.

Address:

Lawrence Livermore Laboratory, Unviersity of Calfiornia
Livermore, Californai 94550

REFERENCE:

PREPRINT UCRL

SUMMARY:

In order to aid in the assessment of the potential biomedical and environmental consequences of coal combusion for electric power generation, we have performed detailed collaborative studies of the physical and chemical properties of size-fractionated coal fly ash. In this report, we demonstrate that many of the physical and chemical properties of aerodynamically size-classified fly ash depend on the relative size distributions of each fraction.

Aerodynamically size-classified fly ash was collected downstream from the electrostatic precipitator (ESP) in the stack breeching of a large southwestern U.S. power plant burning low sulfur (0.5%), high ash (23%) coal. The specially designed collection system (1) which consists of two cyclones and a centripeter separator is capable of size-classifying in situ kilogram quantities of stack fly ash. When used for 12 days to collect fly ash from stack gas, the apparatus yielded a total of 8.08 kg of fly ash in fractions with volume median diameters (VMD) of 20 μm (fraction 4) all with geometric standard deviations of approximately 1.8. The size distribution data determined by optical sizing, centrifugal sedimentation and Coulter analyses are presented.

TITLE:

Analyses of Tars, Chars, Gases, and Water Found In Effluents from the Synthane Process

AUTHOR:

Albert J. Forney, William P. Haynes, Stanley J. Gasior, Glenn E. Johnson, and Joseph P. Strakey, Jr.

ADDRESS:

Pittsburgh Energy Research Center, Pittsburgh, PA

REFERENCE:

Bureau of Mines Application of Improved Technology to Provide Clean Energy Program Technical Progress Report 76, January 1974.

SUMMARY:

Extensive studies have been made of the various effluents found in the Synthane coal-to-gas process. Analyses have been made of the waters, gases, and trace elements present in some of the streams. Results of analyses show the water effluents are the areas where extensive research is needed.

TITLE:

Recovery of Inaccessible Coal Reserves by In Situ Gasification

AUTHOR:

R. C. Forrester III

ADDRESS:

Oak Ridge National Laobratory, Oak Ridge, TN

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering Conference Proceedings
1976 Vol. I

SUMMARY:

Nearly 95% of all U.S. coal reserves are inaccessbile by present surface and deep-mining techniques. Energy contained by many deposits, however, may be largely recovered by in situ gasification which entails injection of oxygen or air with or without steam into a coal seam whose permeability has been enhanced. Injected oxygen permits ignition of the coal and subsequent maintenance of an underground combustion front which produces a flammable product gas. Technical problems associated with this process are addressed by presenting field test results obtained both in the United States and abroad.

TITLE:

Development of Coal Feeders For Coal Gasification Operations

AUTHOR:

Foster-Miller Associates, Inc.

ADDRESS:

Waltham, MA

REF:

Coal Demonstration Plants (Jan-Mar 1977)
DOE/ET - 0027/1
UC89

SUMMARY:

Under the sponsorship of ERDA, coal feeders for use in all coal gasification plants are to be developed through the pilot plant stage by Foster-Miller Associate, Inc. The project recognizes the coal feeder as one element common to all gasification processes. However, no currently available system can handle the quantities of coal, about 1,000 tons per hour, that will be used in commercial processes. These processes require the injection of coal, crushed to 1/8-inch and below, from an atmospheric-pressure hopper into a gasifier whose pressure may be as high as 100 atm.

TITLE:

Coal Gasification Combined-Cycle System for Electric Power Generation

AUTHOR:

FORSTER Wheeler Energy Corporation

ADDRESS:

Livingston, JN

REF:

Coal Gasification (Jan-Mar 1977)
DOE/ET-0024/1
UC-90C

SUMMARY:

The objective of this project is to design a pilot plant capable of producing low-BTU gas from many types of coal and to integrate the coal gasification system with a combined-cycle electric power generating unit. The project is divided into four phases: Phase I-- Technical feasibility studies, Phase II-- Detailed design and engineering of the pilot plant, Phase III -- Pilot plant construction, and Phase IV -- Pilot plant start-up and operation. The current contract covers Phase II.

TITLE:

Brown Coal Gasification with Oxygen or Air in the High-Temperature Winkler Gasifier

AUTHOR:

F.H. Franke and E. Pattas

ADDRESS:

Rheinische Braunkohlenwerke AG,
Cologne
Federal Republic of Germany

REFERENCE:

Technology and Use of Lignite Symposium
Grand Forks, ND, May 1977 (GFERC/IC-77/1) page 258

SUMMARY:

Development work on the Winkler fluidized-bed coal gasification process is being done by Rheinische Braunkohlenwerke, AG, to allow increased operating pressures and temperatures. Use of oxygen or air as the gasifying agents allows production of reducing gases for iron reduction, low Btu gas for power stations, and a synthesis gas for methane, ammonia, or methanol.

TITLE:

Fluidized Combusion of North Dakota Lignite

AUTHOR:

Gerald M. Goblirsch and Everett A. Sondreal

ADDRESS:

Grand Forks Energy Research Center
Envergy Research and Development Administration
Grand Forks, North Dakota

REFERENCE:

Presented at the 9th Biennial Lignite Symposium, Grand Forks, North Dakota, May 18-19, 1977

SUMMARY:

Fluidized-bed combustion (FBC) is the combustion of fuel in a bed of inert or chemically active particles which are held in suspension by an upward flow of air. A bed of fluidized particles behaves very much the same as a boiling liquid. The minimum air velocity required to fluidize the bed is defined by the balance between the aerodynamic drag force on the particles and the gravitational force. The earliest application of the fluidized combustion process is reported by Skinner to be the Winkler Gasification Process of about 1930. At the present time, there is great interest in the fluidized comsion of coal in an environmentally acceptable manner. ERDA is the lead agency in the development of this technology, and is currently operating or in the process of starting up process development units, componenet test units, and demonstration size units, the largest of which is the 30 MW_E unit at Riversville, West Virginia.

The role of the Grand Forks Energy Research Center in the fluidized-bed combustion program is to develop data on sulfur retention on the alkaline coal ash from Western United States coals, when burned in a fluidized-bed combustor without an additive. FBC will result in substantially lower SO_2 emissions than from conventional combustion systems and may, therefore, meet the Federal New Source Performance Standard of 1.2 lb $SO_2/10^6$ BTU. The effects of operating conditions and coal ash compostion on the retention of sulfur dioxide during fluidized-bed combustion of Wester coals will be evaluated to provide a design base for these coals.

TITLE:

Organic Contaminants in Aqueous Conversion Effluents: Environmental Consequences and Research Priorities

AUTHOR:

Stephen E. Herbes, George R. Southworth, Carl W. Gehre

ADDRESS:

Environmental Sciences Division
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37380

REFERENCE:

Publication No. 880, Environmental Sciences Division, ORNL.

SUMMARY:

The anticipated implementation of an extensive coal conversion industry in the United States within several decades will result in production of substantial quantities of highly-contaminated wastewater. Many of the contaminants produced, if released into natural waters, could have deleterious effects on aquatic ecosystems, and ultimately, on human life. Research is required to determine potential acute and subacute effects of potentially hazardous effluents constituents, and to evaluate their transport and persistence in aquatic systems.

To facilitate a rational assignment of future aquatic research priorities to answer these issues, we have initiated a systematic assessment of the environmental hazards of anticipated organic components of aqueous coal liquefaction effluents by the compilation of a critical literature review. Five major classes of organic compounds have been operationally defined: (1) phenols, (2) acrylamines (organic bases), (3) aliphatic hydrocarbons, (4) mono- and polycyclic aromatic hydrocarbons (PAH), and (5) sulfur-containing compounds. We present here a summary assessment of each class on the basis of (1) concentrations anticipated in coal liquefaction effluents, (2) removal by wastewater treatment systems, (3) acute toxicity, (4) chronic toxic effects on aquatic organisms, and (5) environmental transport and presistence. Gaps in understanding and future research needs are identified.

TITLE:

The Potential Toxicity and Bioaccumulation in Aquatic Systems of Trace Elements Present in Aqueous Coal Conversion Effluents

AUTHOR:

Stephen G. Hildebrand, Robert M. Cushman, and Joel A. Carter

ADDRESS:

Environmental Sciences Division, and Analytical Chemistry Division,
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, TN 37830

REFERENCE:

Publication No. 878, Environmental Sciences Division, ORNL

SUMMARY:

Implementation of coal conversion technology on a large scale may result in releases of many elements to aquatic environments. To insure the orderly and safe development of coal conversion technology it is necessary to assess potential adverse impacts of trace element releases on aquatic ecosystems and human health. We present results of analyses for 55 elements in aqueous effluents of a single experimental run of a coal conversion pilot plant. We summarize our review of the literature on toxicity and bioaccumulation factors for aquatic biota of these elements. We relate this review to observed concentrations of elements which have the greatest known potential for toxicity or bioaccumulations, and those elements for which we could not find adequate information to assess potential impacts.

TITLE:

Modification and Operation of an Atmospheric Pressure Ash-Agglomerating Gasifier

AUTHOR:

Institute of Gas Technology

ADDRESS:

Chicago, IL

REF:

Coal Gasification (Jan-Mar 1977)
DOE/ET-0024/1
UC-90C

SUMMARY:

A seven-ton-per-day process development unit, previously operated by IGT under the HYGAS program, demonstrated the operability of the ash-agglomerating process on coke feedstock. Under the current program, the gasifier will be modified to process coal feed. The specific objectives of the contract are to:

Demonstrate the use of the ash-agglomerating gasification process in the production of low-Btu gas from coal at high carbon utilization rates for extended periods of time.

Provide design and cost estimates for both a commercial-scale atmospheric pressure gasifier and a pilot-scale atmospheric pressure gasifier.

TITLE:

The Coal Conversion Systems Technical Data Book

AUTHOR:

Institute of Gas Technology

ADDRESS:

Chicago, IL

REF:

Coal Gasification (Jan-Mar 1977)
DOE/ET-0024/1
UC-90C

SUMMARY:

The Coal Conversion Systems Technical Data Book is being prepared by the Institute of Gas Technology of this project, initiated in October 1974 to provide a single, comprehensive source of data on coal conversion systems. IGT is to provide up-to-date information for the research, development, design, and engineering of coal conversion processes and/or plants. In addition, IGT is to identify those areas where data are required and to suggest research programs that will provide the necessary data not available otherwise. The data book will be published with a loose-leaf binding and loose-leaf sheets will be published periodically for the timely distribution of new and revised data.

TITLE:

Pipeline Gas by Hydrogasification (Hygas Process)

AUTHOR:

Institute of Gas Technology

ADDRESS:

Chicago, IL

REFERENCE:

Coal Gasification (Jan-Mar 1977) p. 13-16
DOE/ET-0024/1
UC-90C

SUMMARY:

The HYGAS Process is being developed by the Institute of Gas Technology (IGT) as part of the joint program of ERDA and the American Gas Association (AGA).

The objective of this contract is to operate the HYGAS pilot plant facility to continue and expand research and development efforts directed toward completion of a commercial concept suitable for producing pipeline quality gas from coal. IGT's specific objectives include:

Development of a high-pressure hydrogasification process that uses all ranks of coal.

Determination of the technical and economic feasibility of the HYGAS process using the steam-oxygen hydrogen-generating system.

Demonstration of the feasibility of ash agglomeration as a technique to increase carbon utilization.

Determination of steady-state conditions and acquisition of scaleup data.

TITLE:

Evaluation of Pollution Control in Fossil Fuel Conversion Process, Gasification: Section 8, Winkler Process

AUTHOR:

C.E. Jahnig

ADDRESS:

Exxon Research and Engineering Company
P. O. Box 8
Linden, N.J. 07036

REFERENCE:

PB 249 846 (NTIS)

SUMMARY:

The report gives results of a review of the Winkler coal gasification process, from the standpoint of its potential for affecting the environment. The quantities of solid, liquid, and gaseous effluents have been estimated where possible, as well as the thermal efficiency of the process. For the purpose of reduced environmental impact, control systems, modifications, and alternatives which could facilitate pollution control or increase thermal efficiency are discussed, and new technology needs are pointed out.

TITLE:

Fossil Fuel Conversion Processes, Gasification; Section I: CO_2
Acceptor Process

AUTHOR:

C.E. Jahnig, E.M. Magee

ADDRESS:

Exxon Research and Engineering Company
P. O. Box 8
Linden, N.J. 07036

REFERENCE:

PB 241 141

SUMMARY:

The report gives results of a review of the CO_2 Acceptor Coal Gasification Process from the standpoint of its effect on the environment. The quantities of solid, liquid, and gaseous effluents have been estimated, where possible, as well as the thermal efficiency of the process. For the purpose of reducing environmental impact, a number of possible process modifications or alternatives have been proposed and new technology needs have been pointed out.

TITLE:

Kinetics of Initial Coal: Hydrogasification Stages

AUTHOR:

James L. Johnson

ADDRESS:

Institute of Gas Technology, 3424 South State Street, Chicago, Illinois
60616

REFERENCE:

Am. Chem. Soc., Div. of Fuel Chem., Preprints, 22 (1), 17 (1977).

SUMMARY:

An experimental study was initiated at the Institute of Gas Technology (IGT) with the objective of quantitatively characterizing intermediate reaction processes occurring prior to completion of the rapid - rate methane - formation reaction. This paper discusses some of the main results obtained thus far in the study of the gasification kinetics of low-rank coals in hydrogen, helium and hydrogen - helium mixtures.

The results obtained in this study indicate that the inital gasification of low-rank coals in hydrogen-containing gases at elevated pressures occurs in two stages. The first stage involves thermally activated devolatilization reactions resulting in the evolution of carbon oxides, water, oil and tar, and some light gaseous hydrocarbons, and leading to the formation of an intermediate simi-char. The second stage occurs consecutive to primary reactions associated with the secondary devolatilization of remaining coal hydrogen, leading to the formation of a relatively nonreactive char. Significantly, yields of methane-plus-ethane, other than that derived from thermal coal-decomposition reactions or from C_3+ light hydrocarbon hydrogenation reactions, are stoichiometrically related to coal hydrogen evolved during the secondary devolatilization stage. This has suggested a model in which the transitions that occur in conversion of semi-char to char, with associated coal hydrogen evolution, involve the formation of a reactive intermediate carbon structure that can either rapidly react with gaseous hydrogen to forma methane and ethane or can convert to nonreactive char. The ratio of methan-plus-ethane formation is independent of temperature but is directly proportional to hydrogen partial pressure.

TITLE:

Donor Solvent Reactions with Coal in a Batch-Recycle System

AUTHOR:

Doohee Kang, L.L. Anderson and W.H. Wiser

ADDRESS:

Department of Mining, Mettallurgical and Fuels Engineering University of
Utah, Salt Lake City, Utah 84112

REFERENCE:

American Chemical Society, Division of Fuel Chemistry Preprints, 22 (2), 160 (1977).

SUMMARY:

Numerous reports concerning kinetics of coal dissolution with hydrogen donor solvent are available. However, little knowledge about the primary products and the reactions which take place in experiments with short residence times have been reported until recently.

This study involved the dissolution of coal in hydrogen donor solvent (tetralin) in a rapid heat and rapid quench batch recycle system. The residence time of the coal-solvent slurry was in the range of a few seconds per pass in the slurry dissolver. The differential reactor system of batch recycle applied here had two main advantages compared with conventional autoclaves. (1) The rapid initial rate was expanded in the time scale of differential conversions; consequently, the initial conditioning period was minimized. In addition, continuous monitoring of data in a single run gave more definitive and smoother results which could probably not have been achieved by batch experiments. (2) A quench system was used which allowed only a few seconds of thermal exposure of the slurry (at the reaction temperature) per pass. This apparently reduced the reorganization and polymerization reactions of the primary reaction products and permitted the analysis of these primary fragmentation products from the dissolution process.

TITLE:

A Research & Development Program for Catalysts in Coal Conversion Process

AUTHOR:

Howard Katzman

ADDRESS:

W.F. Libbey Laboratories
Los Angeles, CA

REFERENCE:

EPRI 207-0-0

SUMMARY:

The use of catalysts in coal conversion processes is reviewed and a research and development program is recommended for catalysis in future coal conversion technology. Emphasis is on those processes leading to clean fuels for electric power generation. A literature survey containing abstracts of more than 400 relevant publications is included.

TITLE:

Composition of Selected Fractions from Coal Tars Produced from an Underground Coal Gasification Test

AUTHOR:

S. Bruce King

ADDRESS:

Energy Research and Development Administration, Laramie Energy Research
Center, P. O. Box 3395, University Station, Laramie, Wyoming 82071

REFERENCE:

Am.Chem. Soc., Div. of Furel Chem., Preprints, 22 (2), 169 (1977).

SUMMARY:

The Laramie Energy Research Center has been developing a technique called the linked vertical well (LVW) process to produce a low-Btu gas by gasifying a coal seam in situ. In addition to this low-Btu gas an organic condensate (called coal tar) was co-produced with the gas. This paper discusses the characterization of this coal tar and considers the following: 1) its value as a petrochemical feedstock or fuel, 2) the possible changes in composition due to changes in reaction conditions, and 3) the possible environmental effects of such a by-product on groundwater quality since the seam is considered to be a low-grade aquifer.

TITLE:

Gasification of Iowa Coal in the Synthane PDU Gasifier

AUTHOR:

R.M Kornosky, S.J. Gasior, J.P. Strakey and W.P. Haynes

ADDRESS:

Pittsburgh Energy Research Center, Energy Research and Development
Administration, 4800 Forbes Avenue, Pittsburgh, PA 15213

REFERENCE:

Am. Chem., Soc., Div. of Fuel Chem., Preprints, 22(2), 197 (1977)

SUMMARY:

Vast deposits of high sulfur caking coals found in the eastern and midwestern United States can be converted to clean gaseous energy by gasification. One important consideration in the development of a coal gasification process is the acceptability of various coal feedstocks. The Synthane process is one such process for the manufacture of high-Btu gas from coal. This report demonstrates the capability of using the Synthane process for the gasification of the mildly caking high sulfur coal from Iowa. This coal is not only present in substantial reserves (7.2 x 19^9 tons) by is also convenient to the large energy markets of the Midwest. The Iowa coal for this study is from the Iowa Coal Project Demonstration Mine #1 of Iowa State University. This coal bed is located in the southwest corner of Mahaska County and is part of the Cherokee Group.

Over all results from an exploratory study to gasify the mildly caking, high sulfur Iowa coal in the Synthane PDU gasified show that carbon conversitons of 80 percent and steam conversitons of 16 percent can be achieved at average mazimum gasifier temperatures of 1832°F and coal throughputs of 40 lb/hr ft^3.

TITLE:

Coal Gasification, A Bibliography with Abstracts

AUTHOR:

Edward J. Lehmann & Kirk G. Werner

ADDRESS:

National Technical Information Service, 5285 Port Royal Road, Springfield,
VA 22151

REFERENCE:

Com-74-10967

SUMMARY:

This bibliography contains 76 selected abstracts of research reports retrieved using the NTIS on-line search system--NTI Search. The period covered is 1964 - May 1974. The topics included cover all aspects of coal gasification which concern the use of coal gas as a fuel or feedstock. Desulfurization of coal be gasification is not covered unless the use of the gas is discussed. Also presented are in situ combustion studies on removing coal from its deposits by underground gasification.

TITLE:

Operation of the Westinghous Fluidized Bed Devolatilizer with a Variety of Coal Feedstocks

AUTHOR:

P.J. Margaritis, S.S. Kim, P. Cherish, L.A. Salvador

ADDRESS:

Westinghouse Research Laboratories, Energy Systems Operations, Madison,
Penn. 15663

REFERENCE:

Am. Chem. Soc., Div. of Fuel Chem. Preprints, 22, (1) 174 (1977).

SUMMARY:

Under Energy Research and Development Administration sponsorship, Westinghouse is conducting a diverse program to develop a low Btu coal gasification, combined cycle electrical power generating process. The total program includes work in gas turbine combustor development, studies of turbine tolerance to erosive and corrosive fuel gas cleaning and coal gasification process development. As part of the gasification work, Westinghouse is operating a process development unit (PDU) at Waltz Mill, Pennsylvania. It is this aspect of the program that the paper discusses.

The results of this study of char product characteristics along with the other results achieved during the past year of testing with the devolatilizer reactor indicate that the design concept for this portion of the process is feasible. Highly caking coals were processed for over two-hundred hours without pre-treatment utilizing the draft tube and recirculating fluidized bed concept. Char product produced in the process was adequately devolatilized and was in an acceptable size range, for both overhead and bed material fractions, to be used in the gasifier-agglomerator reactor. The attrition growth of particles which occurred was within acceptable limits with respect to overall process dynamics. To some extent, the resulting char particle size distribution depends on freeboard gas velocity, coal feed rate and coal rank.

TITLE:

Ground-Water Quality Effects of an Underground Coal Gasification Experiment

AUTHOR:

S. Warren Mead, John W. Campbell, Douglas R. Stephens

ADDRESS:

Lawrence Livermore Laboratory
P. O. Box 808
Livermore, CA 94550

SUMMARY:

Ground-water sampling and analysis have been carried out at the site of an in situ coal gasification experiment conducted by the Lawrence Livermore Laboratory (LLL) near Gillette, Wyoming. An important environmental question associated with the in situ gasification of coal concerns the possibility that reaction products (ash and tars) left underground following the gasification process may lead to the contamination of local ground waters. In an effort to clarify the significance of this problem, we have sampled the water from more than 12 wells in the vicinity of an underground gasification experiment before, during, and up to 6 months following gasification. Water samples were analyzed in the field and at LLL, U.S. Geological Survey, and Research Triangle Institute for a variety of characteristics, including the presence of 70 inorganic elements and compounds, phenolic materials, dissolved organic carbon, and volatile organics. We find a greatly increased concentration of phenolic materials, dissolved organic carbon, and volatile organics. We find a greatly increased concentration of phenolic materials (450 mg/l) just outside the burn boundary, and a variety of inorganic species issuing from within the residual ash bed. All contaminants decrease rapidly with distance, although above-background levels of some species were detected 100 feet from the burn zone. Several important contaminants showed a large decrease in concentration with time, possibly a result of adsorption.

Coal Gasification Plants

TITLE:

Conclusions and Recommendations from Workshop on Materials Problems and Research Opportunities in Coal Converstion, Vol. I.

AUTHOR:

The Department of Metallurgical Engineering, the Ohio State University, Columbus, Ohio; R.W. Staehle, Workshop Director. Sponsored by the National Science Foundation, and the Office of Coal Research

ADDRESS:

Corrosion Center, The Ohio State University, 116 West 19th Avenue, Columbus,
Ohio 43210

SUMMARY:

This meeting was organized to identify and assess materials problems which may limit the performance of equipment in coal conversion technology. Attention was given to processes which produce intermediate and high BTU gas, liquid products, and gasification processes which has associated turbine cycles. Recommendations were prepared for substantive research and development work which would assure the reliable and economical performance of materials. The recommendations were prepared by topical workshops which considered 18 component areas of materials performance in coal conversion technology. The recommendations from each of the workshops were evaluated by the attendees according to a priority rating. In addition, written discussions were prepared by attendees as the recommendations from the various workshops were presented.

TITLE:

Characteristics of Chars Produced by Pyrolysis Following Rapid Heating of Pulverized Coal

AUTHOR:

N. Nsakala, R.H. Essenhigh, and P.L. Walker, Jr.

ADDRESS:

The Pensylvania State Unviersity, Materials Sciences Department, University
Park, Pensylvania 16802.

REFERENCE:

Am. Chem. Cocl, Div. of Fuel Chem. Preprints, 22 (1), 102 (1977).

ABSTRACT:

Due at least partly to the dwindling native supplies of oil and natural gas, major research and development efforts aimed at converting coal into alternative fuels are currently underway in this country. During these various coal conversion processes two main events take place, namely: (i) evolution of the volatiles (pyrolysis) and (ii) gasification of the solid residue.

The understanding of the mechanisms of pyrolysis and gasification of coal is therefore important for achieving optimization of any conversion process. Nevertheless, the complexity of this subject matter is so great that it is always desirable to study pyrolysis separately from gasification. Accordingly, this paper describes experiments in which closely size graded pulverized coal particles were pyrolyzed (in a laminar flow pyrolysis furnace) following a rapid rate of heating. The resulting chars were examined to determine the changes in physical characteristics due to rapid heating.

TITLE:

Clean Power Generation from Coal

AUTHOR:

Office of Coal Research

ADDRESS:

Department of the Interior
Washington, D.C. 20240

REFERENCE:

R. and D Report No. 84

SUMMARY:

The Westinghouse Electric Corporation, through its Research Laboratories, entered into a three-year research and development contract on clean power generation from coal. The objectives were to provide more extensive and detailed information in systems study and evaluation of power generation devices, magnetohydrodynamic generators, fuel cells, and gas turbines; fuel gas cleaning by cyclones and precipitators; hydrogen generation for coal gasification and gaseous and liquid fuel coproduct production, or both; and superconductive detransmission.

Prior to cancellation of the contract some six months after its award, significant progress had been made on several tasks. No work was done, however, on superconductive detransmission. Work on magnetohydrodynamics (MHD) was initially cancelled, but reinstated several days later. The work done under the MHD contract is not covered in this report.

We strongly recommmend that the original comprehensive project be reinstated to provide the necessary design data to economically utilize coal as a clean source of fuel in the immediate future.

TITLE:

Wet Scrubbers vs Electrostatic Precipitators: Relative Particulate Inhalation Hazards for Toxic Species

AUTHOR:

John M. Ondov, Richard C. Ragaini, and Arthur H. Biermann

ADDRESS:

Lawrence Livermore Laboratory, Unviersity of California
Livermore, California 84550

REFERENCE:

Preprint UCRL-78359 Rev. 1

SUMMARY:

Elemental emissions and particulate size distributions are compared for a Venturi scrubber and an electrostatic precipitator (ESP), both in use at a large western coal-fired power plant. Potential pulmonary deposition of toxic particles from the two devices suggests that electrostatic precipitators provide greater control of the emission of particles most hazardous to humans.

TITLE:

The Synthane Process-Research Results and Prototype Plant Design

AUTHOR:

Pittsburgh Energy Research Center

REFERENCE:

OP 160-73

SUMMARY:

The paper discusses the development of the Synthane Process at the Bureau of Mines laboratories at Bruceton, Pennsylvania, the research on a Synthane gasifier done at the Hydrocarbon Research, Inc., plant in Trenton, New Jersey, and the Lummus design of the 75-tpd prototype plant to be constructed at Brucetone.

Because of the importance of environmental problems, the pollution aspects of the Synthane Process and solutions are also discussed.

TITLE:

Trace Elements in California Aerosols Part 1. Instrumental Neutron Activiation Analysis Techniques

AUTHOR:

R.C. Ragini, Hr. R. Ralston, D. Garvis, and R. Kaifer

ADDRESS:

Lawrence Livermore Laboratory, Unviersity of California
Livermore, California 94550

REFERENCE:

Distribution Category UC-11, UCRL-51850

SUMMARY:

Instrument Neutron Activation Analysis (INAA) done at LLL played a key role in the 1972-1974 California Aerosol Characterization Experiment (A CHEX), a major experiment in the chemistry of aerosols in urban and non-urban sites of California sponsored by the State of California Air Resources Board.

The main purpose of INAA was to measure the particle size distributions and diurnal patterns of key chemical constitutents in aerosols collected in California. These data were used to satisfy some of the key objectives of A CHEX, including aerosol characterization and evaluation of the origins and evolutions of aerosols.

Secondary uses of INAA were the validations of the Lundgren rotating drum cascade impactors used in the A CHEX, and validations of other analytical techniques used in the chemical analyses.

As a result of these studies, it was concluded that techniques using INAA were useful operational methods for chemical analysis of aerosols collected over two-hour periods in urban air with an active monitoring program.

TITLE:

Evnironmental Trace Metal Contamination in Kellogg, Idaho, Near Zinc and Lead Smelters

AUTHOR:

R.C. Ragaini, H.R. Ralston, N. Roberts, D. Garvis, and A. Langhorst

ADDRESS:

Lawrence Livermore Laboratory, University of California
Livermore, California 94550

REFFRENCE:

Preprint UCRL-77733

SUMMARY:

Soil cores, grasses, and ambient air aerosols were sampled in the vicinity of Zn and Pb smelters in Kellogg, Idaho. Of 34 elements analyzed by instrumental neutron activation and x-ray fluorescence, Cd, Sb, Ag, Pb, Au, Z, Se, As, In, Ni, Cu, and Hg were the most highly enriched, ranging in surface soils up to 7,900 ppm lead, 29,000 ppm zinc, and 140 ppm cadmium. For grasses, lead ranged up to 10,000 ppm, zinc to 12,000 ppm, and cadmium to 4400 ppm. Aerosol enrichments above contributions from local resuspended soils were 4,100 for cadmium, 180 for arsenic, 110 for lead, and 60 for zinc.

Soil profiles, aerosol enrichments, and factor analysis of air filter data indicate that the major sources of the above twelve elements in the atmosphere are the smelting operations.

TITLE:

Environmental Interactions

AUTHOR:

R. H. Ross

REF:

Environmental, Health, and Control Aspects of Coal Conversion: An Information Overview. 2, 6/1-6/123, (1977) ORNL/EIS-95

SUMMARY:

The future of coal conversion cannot be adequately assessed without considering the environmental impact of possible effluents from conversion processes. This chapter will attempt to explore the fate of potential coal conversion pollutants in the environment by considering such factors as mobility, transport, bioaccumulation, retention, and degradation. Four principal classes of pollutants will be reviewed: hydrocarbons (particularly polycyclic aromatic hydrocarbons), trace elements, sulfur oxides, and nitrogen oxides.

The behavior of a chemical pollutant introduced into the environment depends largely upon two factors - the nature of its surroundings and the physico-chemical properties of the pollutant. For example, transformations can occur in all environmental media - hydrosphere, lithosphere, atmosphere, and biotic component of the environment. Likwise, in the media, the behavior of a chemical is determined by its solubility, vapor pressure, adsorption ability, and degradability.

TITLE:

Low BTU Gasification

REFERENCE:

Shaping Coal's Future through Technology, 1974-1975
Office of Coal Research, Washington, D.C. 20242
Stock #024-014-0012-2

SUMMARY:

Low-BTU gas from coal offers one of the most promising methods of using coal as a utility fuel in an economic and environmentally acceptable manner. This program promises a higher conversion efficiency than high-BTU gasification.

The objective is to provide the technology required to begin commercial application by FY 1979, and permit the widespread commercial utilization of low-BTU gasification by the mid-1980's.

The program will provide for the development of gasifiers for operation at near-atmospheric and higher-than-atmospheric pressures. However, the state of development of near-atmospheric gasification is currently more advanced than that of pressurized gasification. For this reason, and in order to provide a commercially acceptable process at the earliest possible date, the strategy or intent of the program is to promote the development of near-atmospheric gasifiers as a primary development of higher pressure gasifiers.

In addition, the use of a clean, particle-free low-BTI gas in a combined gas turbine-steam turbine power cycle offers the possiblility of a significant increase in thermal efficiency for electrical power generation.

Different processes have been found to be optimum for different types of coal. Each of these processes involves unresolved problems as discussed, and in some cases, appear to be redundant. However, only through a systematic approach which addresses itself to the resolution of the problems of each of the various processes can the optimum process or processes be identified for ultimate selection.

The basic types of gasifiers to be developed for use at both atmospheric and/or higher pressures are briefly discussed below:

Fixed-Bed Gasifiers--In this process, the coal particles are supported on a fixed grate with steam plus oxygen or air being supplied to provide for the necessary gasification reaction.

Entrained-Bed Gasifiers--In an entrained- or suspension-bed gasifier, the solid particles are carried throughout the reactor entrained in the gas flow; the necessary small size of the particles for entrainment permits high reaction rates. Also, since the particles are in suspension and are rapidly heated through the plastic range, the agglomerating problems of the fixed-bed gasification are eliminated.

TITLE:

Potential Trace Elements Emissions from the Gasification of Illinois Coals

AUTHOR:

N.F. Sather, W.M. Swift, J.R. Jones, J.L. Beckner, J.H. Addington and R.L. Wilburn

ADDRESS:

Argonne National Laboratory, 9700 South Cass Avenue, Argonne, Illinois
60439

REFERENCE:

ANL-75-XX-1

SUMMARY:

Results of comprehensive trace element analyses of samples of Illinois #5 and #6 seam coals and the unquenched ashes obtained from gasification of these coals in a Lurgi reactor are reported and discussed. Areas where additional background information is needed for assessment of the environmental impact of trace element emissions from coal gasification are identified.

TITLE:

Membrane Applications to Coal Conversion Process

AUTHOR:

W.J. Schell, W.M. King

ADDRESS:

Envirogenics Systems Company, El Monte, California

REFERENCE:

FE 2000-2

SUMMARY:

A major portion of the technical effort this quarter involved a continuation of the characterization of cellulose acetate blend membranes. This study consisted of measurements of permeation rates and separation factors for hydrogen, methane, carbon monoxide and nitrogen at pressures as high as 1500 psig and temperatures up to 65°C. A heat-treatment temperature study was also made in order to optimize blend membrane performance. An investigation of "free-standing" membrane was conducted as a method of improvement of membrane reproducibility and avoidance of membrane curl induced by high shrinkage during solvent exchanging and drying.

Determining a method to reduce brittleness in cellulose acetate membranes has been an important investigative area, but so far the effort has been fruitful in elucidation a suitable procedure for improving membrane flexibility. The study has involved addition of cellulose acetate butyrate to blend formulations and the use of higher molecular weight cellulose acetate in blend formulations.

An intensive polysulfone membrane development effort was initiated this quarter. The approach consisted of varying solvent ratios, drying times and gelation media at several polymer concentrations. The resulting membranes were evaluated from gas permeation rate measurements.

TITLE:

Mixing and Reaction of Pulverized Coal in an Entrained Gasifier

AUTHOR:

L. Douglas Smoot, F. Douglas Skinner, and Richard W. Hanks

ADDRESS:

Chemical Engineering Department, Bringham Young Universiy, Provo, Utah 84602

REFERENCE:

Am. Chem. Soc., Div. of Fuel Chem. Preprints, 22 (1), 77 (1977).

SUMMARY:

Several coal gasification processes under development include an entrained gasifier as one step in the process. In such cases, coal or char is contacted with a hot gas to cause particle combustion or gasification. Design and optimization of such units require an understanding of particle gasification kinetics, together with insight into turbulent mixing processes of the coal-laden streams with the hot gases. The present study is designed to develop an understanding of the physical and chemical rate processes that occur during gasification of entrained, pulverized coal particles.

Specific objectives are to measure locally: (1) the extent of mixing of primary and secondary gases, (2) the extent of particle dispersion, (3) the extent of particle reaction, and (4) the gaseous reaction products including pollutants. This study includes both non-reacting flow tests to be run at pressures from 1 to 20 atm. Key to the technical approach is particle and gas sampling from the reactor using water-cooled probes. Separate key components in primary and secondary streams will indicate directly the extent of gas phase mixing at the various sampling points. The particulate portion of each sample will be analyzed to determine ash, volatiles, and sulfur and nitrogen content.

TITLE:

Trace Elements: Analysis of Their Potential Impact form a Coal Gasification Facility

AUTHOR:

Mason H. Somerville, James L. Elder, and Robert G. Todd

ADDRESS:

Engineering Experiment Station, University of North Dakota, Grand Forks, ND

REFERENCE:

Technology and Use of Lignite Symposium, Grand Forks, North Dakota, (May 1977), GFERC/IC-77/1 (Page 285).

SUMMARY:

An analysis of the potential impact of trace elements emitted from a proposed 250 MMSCFD dry-ash Lurgi coal-gasification facility is reported. Baseline data of the trace elements in the overburden from the proposed mine area, overburden leachdate data, coal, oil, tar, and ash and its leachate data are included and discussed. A prediction of the effluent quantity and the distribution around the proposed facility for 73 elements is presented. Four of the 73 elements considered (sodium, molybdenum, boron, and arsenic) were chosen for wheat plant toxicity tests.

Results of the study indicate that the leaching of trace elements from the returned overburden and disposed ash buried in the mine area will not pose a significant environmental problem. Tests indicate that wheat plant toxic levels will not be reached even if leaching of the overburden and disposed ash occurs. A recommendation is made and justification presented for not regulating trace element emissions at this time.

TITLE:

Trace Elements: Analysis of Their Potential Impact from a Coal Gasification Facility

AUTHOR:

Mason H. Somerville, James L. Elder, Robert G. Todd

ADDRESS:

Engineering Experiment Station, University of North Dakota, Box 8103,
Grand Forks, ND 58202

SUMMARY:

An analysis of the potential impact of trace elements emitted from a proposed 250 MMSCFD dry ash Lurgi coal gasification facility is reported. Baseline data of the trace elements in the overburden from the proposed mine area, overburden leachate data, coal, tar and ash and its leachate data are included and discussed. A prediction of the effluent quantity and the distribution around the proposed facility for seventy-three elements is presented. Four of the seventy-three elements considered (sodium, molybdenum, boron, and arsenic) were chosen for wheat plant toxicity tests.

The research of the study indicated that it is highly improbable that the leaching of trace elements from the returned overburden, and disposed ash buried in the mine area will pose a significant environmental problem. The results of the toxicity tests indicate that it is highly improbable that wheat plant toxic levels will be reached even if leaching of the overburden and disposed ash occurs. A recommendation is made and justification presented for not regulating trace elements emissions at this time.

TITLE:

SO_2 Removal Using Ash-Akali Wet Scrubbing

AUTHOR:

Everett A. Sondreal

ADDRESS:

Grand Forks Energy Research Center, Grand Forks, N.D.

REFERENCE:

GFERC/QTR - 76/3 UC 90

SUMMARY:

The fly ash derived from some Western coals contain significant amounts of soluble sodium and magnesium, and high concentrations of these elements will result after long-term operation of a closed-loop scrubber employing the fly ash alkali scrubbing process. During this quarter, tests have been carried out in the 130 scfm GFERC scrubber on high sodium and magnesium fly ash under widely varying conditions. In addition, reliabliity tests were initiated at the 5000-acfm pilot scrubber located at the Milton R. Young Power Station. The reliability tests are being conducted under a cooperative agreement among GFERC, Square Butte Electric Cooperative, Minnesota Power and Light Company, and Combustion Equipment Associates.

TITLE:

Product Composition and Kinetics of Lignite Pyrolysis

AUTHOR:

Eric M. Suuberg, William A. Peters, and Jack B. Howard

ADDRESS:

Department of Chemical Engineering and Energy Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

REFERENCE:

Am. Chem. Soc. Div. of Fuel Chem.
Preprint, 22 (1), 112(1977).

SUMMARY:

The pyrolysis of pulverized Montana lignite by time-resolved measurement of the yields and compositions of products formed under controlled temperature-time histories was studied in a captive sample apparatus. A thin layer of particles held in a folded strip of stainless steel screen was electrically heated under both 1 atm helium and a vacuum in a vessel connected to a series of product recovery traps. The temperature of the sample was measured with a thermocouple. Heating rate, peak temperature attained, and residence time at the peak temperature were independently varied in the ranges 100-10^4 °C/s, 150-1100°C, and 0-10s. The yields of char and tar were determined gravimetrically and selected char samples were subjected to elemental analysis. The yields of water, carbon, monoxide, carbon dioxide, hydrogen, and hydrocarbon gases and light liquids were determined by gas chromatography.

The yields of all the volatile products increase monotonically with temperature and approach asymptotic values at the higher temperatures. At 1000°C/s and 1 atm helium the ultimate yields, in percent by weight of the lignite (as-received), are 16.5% water (including 6.8% moisture), 9.5% carbon dioxide, 9.4% carbon monoxide, 5.4% tar, 1.3% methane, 0.6% ethylene, 0.5% hydrogen, and 0.9% ethane, propylene, propane, benzene, and trace hydrocarbons. The total yield of 44.0% is close to the ASTM volatile matter plus moisture (43.7%). Pyrolysis at the highest temperatures volatilizes about 70% of the sulfur and about 25% of the nitrogen; the percent by weight of sulfur in the char is less than that in the lignite but the reverse is true for nitrogen.

TITLE:

Computer Modeling of Coal Gasification Reactors

AUTHOR:

Systems, Science and Software

ADDRESS:

LaJolla, CA

REF:

Coal Gasification (Jan-Mar 1977)
DOE/ET-0024/1
UC-90C

SUMMARY:

Under the terms of this ERDA contract, Systems, Science, and Software (S^3) is to develop a general computer model of coal gasification reactors. The model will combine theoretical descriptions of the thermo-mechanical interactions between the solid and gas phases with a kinetic model of chemical reactions based on the best experimental data available at the time of program development. The model will be used to expedite the development, aid in optimization, and assist in the scale-up of coal gasification reactors. The model will first be applied to high-Btu fluidized-bed gasification processes and later expanded to include low-Btu fluidized-bed reactors, entrained-flow reactors, and fluidized-bed combustors.

TITLE:

Hydrogasification of Brown Coal Using Process Heat From High Temperature Gas-Cooled Nuclear Reactors

AUTHOR:

H. Teggers and G. Falkenhain

ADDRESS:

Rheinische Braunkohlenwerke, AG
Cologne
Federal Republic of Germany

REFERENCE:

Technology and Use of Lignite Symposium
Grand Forks, ND May 1977 (GFERC/IC-77/1, page 248)

SUMMARY:

In conventional gasification processes, thermal requirements are supplied by combustion of some of the feed coal. A more economical method of supplying heat is the use of heat from gas-cooled, high-temperature reactors. About 40 percent of the feed coal may be conserved.

In the project "Prototypanlage Nukleare Prozesswarme," sponsored by the Ministry of Research and Technology of the Federal Republic of Germany, design data for a commercial-scale plant have been completed. Part of this project is a pilot plant for hydrogasification of coal in a fluidized bed at elevated pressure. The pilot plant is operated by the Rheinische Braunkohlenwerke. Data verified the basis for the process schemes selected for commercial-scale units. Carbon gasification of 64 percent, a coal gasification of more than 70 percent, and a methane content in raw gas of over 30 percent were obtained. The throughput of coal was higher than originally designed.

TITLE:

Catalysis of Char Gasification by Minerals

AUTHOR:

A. Tomita, O.P. Mahajan and P.L. Walker, Jr.

ADDRESS:

Material Sciences Department, Penn State University, University Park, Penn.
16802

REFERENCE:

Am. Chem. Soc., Div. of Fuel Chem., Preprints, 22 (1), 4 (1977)

SUMMARY:

It is well known that most minerals act more or less to catalyze carbon gasification. In coals, there are two broad classes of inorganic impurities--the discrete mineral matter, which is usually present in particles greater than about 1 μm in size, and the minor and trace elements, which are more or less associated with the organic phase or mineral phase in a highly dispersed state. Because of current interest in producing low and high BTU gases by coal gasification, it is desirable to know to the extent to which inorganic impurities in chars (as a result of being present in the original coals) increases gasification rates. The aim of the present study is to investigate possible catalytic activity of major minerals found in coals for char gasification in air, CO_2 and H_2. Since coals and, hence, chars are invariably associated with many inorganic impurities, a high purity polymer char have a structure similar to coal-derived chars has been used in the present study.

TITLE:

Mass and Heat Balance for Coal Gasification by Atomic International's Molten Salt Gasification Process

AUTHOR:

Charles A. Trilling

ADDRESS:

Atomics International, 8900 DeSoto Avenue, Canoga Park, CA 91304

REFERENCE:

Am. Chem. Soc., Div. of Fuel Chem. Preprints, 22(1), 185 (1977)

SUMMARY:

Rockwell Internationals's Atomics International (AI) Division is presently developing molten salt processes for the gasification of coal. In these processes the coal is oxidized and completely gasified by reaction with air or with oxygen and steam in a bed of molten sodium carbonate. The gasification takes place at temperatures of 1700 to 1800°F and pressures of 10 to 30 atm. The sulfur and ash of the coal are retained in the melt. A nonpolluting low-or medium-Btu gas is produced which can be used as fuel gas for electric utility or industrial applications or as a synthesis gas for the production of pipeline quality gas, methanol, or liquid hydrocarbons. A sidestream of melt is withdrawn from the gasifier and processed in an aqueous regeneration system for removal of ash, recovery of elemental sulfur, and return of the regenerated sodium carbonate to the gasifier.

This report describes the mass and heat balance around the molten salt gasifier and the composition of the fuel gas produced as a function of air-to-coal oxygen-and steam-to-coal feed ratios and system heat losses. Calculated values are compared with the experimental data obtained in laboratory and small scale pilot plant tests.

TITLE:

Advanced Coal Gasification System for Electric Power Generation

AUTHOR:

Westinghouse Electric Corporation

ADDRESS:

Lester, PA

REF:

Coal Gasification (Jan-Mar 1977) p. 41-44
DOE/ET-0024/1
UC-90C

SUMMARY:

The advanced coal gasification system for electric power generation is being developed by Westinghouse Electric Corporation. The primary objective of this contract is to develop a fluidized-bed system for producing low-Btu gas from coal and apply the system to a combined-cycle electric generation system.

TITLE:

Pyrolysis of Lary Coal Blocks: Implications of Heat and Mass Transport Effects for In situ Gasification

AUTHOR:

Pillip R. Westmoreland and Richard C. Forrester III

Address:

Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830

REFERENCE:

Am. Chem. Soc., Div. of Fuel Chem., Preprints, 22(1), 93 (1977)

SUMMARY:

Dewatering of coal blocks at in situ moisture levels was shown to markedly affect pyrolysis gas production by being the rate-limiting mechanism in heat transfer, and by causing self-gasification of the block as steam diffuses from a shrinking core of damp coal through a hot, outer layer of char. Cracking of product oil vapors as they diffuse outward may also contribute to the increased combustible gas evolution of block pyrolysis compared to powder pyrolysis.

These results influence modeling and design of in situ gas gasification. Since no data are available on coal-block pyrolysis, improved understanding of heat and mass transfer effects significantly improves semitheoretical models which have depended on powder pyrolysis data. For satisfactory resource recovery, the shrinking core of unreacted coal makes it critical to limit flame-front speed. If the flame front moves too fast, only an outer layer of any large masses of coal will be gasified, leaving damp, ungasified centers behind the front.

TITLE:

Environmental Contamination from Trace Elements in Coal Preparation Wastes: A Review and Assessment of the Literature

AUHTOR:

E.M. Wewerka, J.M. Willimas, P.L. Wanek, and J.D. Olsen

ADDRESS:

Los Alamos Scientific Laboratory, University of California, Los Alamos,
New Mexico 87544

REFERENCE:

ERDA LA-6600-MS; EPA-600/7-76-007, August 1976

SUMMARY:

The purpose of this review of the literature is to collect and evaluate the available information on the chemistry and behavior of trace elements in coal processing wastes, and to utilize this information to assess the potential for environmental contamination from the trace elements in these wastes. Only limited attention has been given previously to the chemistry of trace elements in coal waste materials; however, most of the growing body of knowledge concerning trace elements and minerals in raw coals can be applied directly to coal wastes. The consensus from analytical studies is that nearly every naturally occurring element is likely to be present in coal and coal refuse. The fate of these elements during coal preparation is poorly defined; however, large concentrations of trace elements are discarded in the washing refuse. Toxic or harmful quantities of elements, such as Fe, Al, Mn, Co, Ni, and Zn are released into the environment in the drainage from coal mineral wastes, but, in general, the behavior of trace elements during refuse weathering, leaching, and burning is not well understood. Although the mineral and inorganic matter in coal wastes is an acknowledged major contributor to both air and water pollution, without the benefit of further research, a comprehensive assessment of the full potential for environmental contamination from the trace elements in these wastes cannot be made.

TITLE:

Dry Table - Pyrite Removal from Coal

AUTHOR:

Donald C. Wilson

ADDRESS:

Central Engineering Laboratories, FMC Corporation, 1185 Coleman Avenue,
Santa Clara, California 95052

REFERENCE:

American Chemical Society, Division of Fuel Chemicals Preprints 22 (2), 132 (1977).

SUMMARY:

This paper discusses the use of a vibrating dry table method for the removal of pyrite from coal. Due to the differences in size, shape, bulk density, resiliency and surface roughness between coal and pyrite particles, their separation may be accomplished by this method. The equipment design, operating parameters and some experimental results are given.

TITLE:

Animals: Bioenvironmental Effects

AUTHOR

D.J. Wilkes

REF:

Environmental Health and Control Aspects of Coal Conversion: An Information Overview. 2 9/1-9/144, (1977) ORNL/EIS-95

SUMMARY:

Many organic compounds may be released into the environment from coal conversion processes. Polycyclic aromatic hydrocarbons (PAH) and heterocyclic compounds containing either nitrogen or sulfur have been identified as organic compounds of particular environmental concern because of their carcinogenic potential.

TITLE:

Gasification of a Highly Caking Coal in the GEGAS Pressurized Gas Producer

AUTHOR:

D.E. Woodmansee and P.M. Palmer

ADDRESS:

General Electric Company, Corporate Research and Development Center,
Schenactady, New York

REFERENCE:

Am. Chem. Soc., Div. of Fuel Chem. Preprints, 22 (1) 158 (1977)

SUMMARY:

The purpose of this paper is primarily to describe the results from the GEGAS producer operating with a highly caking coal at low steam consumption. It can be concluded from the preliminary trials that crushed, run-of-mine, highly caking Pittsburgh #8 coal can be gasified successfully in a fixed-bed gasifier with periodic deep-bed agitation. This verifies and extends results obtained on the Morgantown Energy Research Center gasifier with continuous deep-bed agitation. Results from both experiments confirm that this difficult coal can be gasified with a low steam consumption with steam-to-air mass ratios near or less than 0.2 in the reactor blast at pressures between 6 and 20 atmospheres. Moreover, the present experiment has given a preliminary indication that refractory-lined shafts are compatible with low steam/air, stirred-bed operations with this difficult coal. The use of insulated, rather than water-cooled shafts and periodic vs. continuous bed agitation seems to be worth from 5 to 10 points in cold gas conversion efficiency in 3 to 3 1/2 foot diameter pilot units.

TECHNICAL REPORTS:
GEOTHERMAL ENERGY PRODUCTION

TITLE:

Subsurface Techniques for Locating and Evaluating Geopressured Geothermal Reserviors along the Texas Gulfcoast

AUTHOR:

D.G. Bebout

ADDRESS:

Bureau of Economic Geology
The University of Texas at Austin

REFERENCE:

Proceedings of the Second Geopressured Geothermal Energy Conference, Austin, Texas, Feb. 23-25, 1976.

SUMMARY:

A potential geothermal reservoir along the Texas Gulf Coast should have a volume of at least three cubic miles (which translates into a cumulative sand thickness of greater than 300 feet and areal extent of 50 square miles), greater than 250°F uncorrected subsurface fluid temperature, and permeability greater than 20 millidarcies. Based on analyses from actual water samples and interpretation from log analysis, deep-subsurface fluids are expected to have salinities lower that 20,000 ppm and perhaps as low as 5,000 ppm (Jones, 1975). Most well reports indicate that the water will be saturated with methane gas.

This report describes techniques being used in the assessment of geopressured geothermal resources along the Texas Gulf Coast and defines geological procedures for test- or industrial-site section. These approaches have been proven in petroleum exploration and are applicable in geothermal exploration here in the Gulf basin and in other sedimentary basins.

TITLE:

Resevoir Mechanics of Geopressured Aquifiers

AUTHOR:

William J. Bernard

ADDRESS:

Louisiana State University, Baton Rouge, LA

REFERENCE:

Proceedings: First Geopressured Geothermal Energy Conference, June 1975.

SUMMARY:

To evaluate the practicality of producing energy from geopressured aquifers, methods to predict energy-production rates are necessary. This paper reviews established petroleum-resevoir engineering techniques as applied to geopressured systems. Also, the effects of dissolved natural gas, shale water influx, and abnormally high rock compressibilities on aquifer behavior are discussed.

TITLE:

The Potential National Benefits of Geothermal Electrical Energy Production from Hydrothermal Resources in the West

AUTHOR:

C.H. Bloomster and R.L. Engel

ADDRESS:

Pacific Northwest Laboratories, Richland Washington 99352

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering Conference Proceedings
1976 Vol I

SUMMARY:

To evaluate the competitive role of geothermal energy in a predominately nuclear and coal based electric power economy, we employed a computer simulation of the U.S. power economy. The simulation optimizes the installation of new generating capacity on a multiregional basis. This study included only the hydrothermal resources in the West. New geothermal capacity in the West, however, has national impact through reducing the demand and the cost of nuclear and fossil fuels. The potential benefits from geothermal energy are estimated at \$2-\$8 billion in reduced electricity costs. Geothermal energy is estimated to achieve 8-20% of the electricity generation in the West (9,000-17,000 MWe by 1990). Our "most likely scenario" is the lower values in the above ranges. This scenario would save (1) \$11 billion in powerplant capital costs, (2) 32 million separative work units, (3) 64,000 tons (58.2×10^3 tonne) of U_3O_8, and (4) 700 million barrels (112×10^6 m^3) of oil.

TITLE:

Guidelines Acquiring Environmental Baseline Data on Federal Geothermal Leases

AUTHOR:

Max D. Crittenden, Jr.

ADDRESS:

United States Department of Interior
Menlo Park, California

SUMMARY:

These guidelines are developed to assist geothermal leases and operators in complying with Federal Regulation 30 CFR 270.34 (k) which states that a plan of operation shall include "A requirement for the collection of data concerning the existing air and water quality, noise, seismic, and land subsidence activities, and ecological system of the leased lands covering a period of at least one year prior to the submission of a plan for production."

The purpose of collecting environmental data is to provide a baseline representing selected physical, chemical, and biological conditions prior to significant disturbance by leased operations against which later environmental data can be compared. This comparison will provide a basis for determing the net environmental change attributable to the operations on the leasehold at any subsequent time.

The purpose of these guidelines is to aid those involved in the exploration for geothermal resources in meeting the requirements for baseline data in a timely manner. Where unit operations are involved these guidelines should apply to the entire unit in the same way as to an individual leasehold. Their timing is desigend to coordinate with the generalized scheme of phased operations outlined in orders issued or to be issued by the Supervisor, Conservation Division, USGS.

TITLE:

Geothermal Steam Pricing of the Geysers, Lake and Sonoma Counties California

AUTHOR:

John L. Dutcher and Leo H. Moir

ADDRESS:

455 Golden Gate Avenue, San Francisco, CA

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering Conference
Proceedings 1976 Vol. I

SUMMARY:

One utility company in the United States produces electricity from geothermal steam. This company buys the steam from several steam producers under contracts with essentially identical rate provisions. These provisions are based on historical fossil-fuel costs and plant efficiency and nuclear generation costs experienced by the utility. A change in the parameters of generation, efficiency, or fuel costs will change the geothermal steam rate. Several changed circumstances are postulated and their effect on the geothermal steam rates considered.

TITLE:

Fluidized Bed Heat Exchangers for Geothermal Applications

AUTHOR:

C.A. Ellen, E.S. Grimmett, K.L. Wagner

ADDRESS:

Allied Chemical Corporation, Idaho Falls, Idaho

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering Conference Proceedings
1976, Vol. I.

SUMMARY:

Bench-scale liquid-fluidized bed heat exchangers used with geothermal water prevented fouling and nearly doubled the rate of heat transfer compared to identical tube and shell arrangements. A six-inch pressured unit operated at the Raft River geothermal site near Malta, Idaho verified these results. Horizontal and vertical configurations and other design considerations are discussed. Insufficient data currently exist to make valid correlations for scale-up for demonstration or commercial size units. An experimental program is in progress to correct this deficiency.

TITLE:

Geothermal Systems and Power Development

AUTHOR:

A.J. Ellis

ADDRESS:

Chemistry Division, Department of Scientific and Industrial Research
New Zealand

REFERENCE:

American Scientist, Sept.-Oct. 1975, p. 510

SUMMARY:

This article provides a brief outline of the nature of geothermal fields, geothermal power projects, and some development problems. The topic was covered thoroughly in a series of papers presented in a United Nations Symposium on the Development and Utilization of Geothermal Resources at Pisa, Italy, in late 1970 (Geothermics 1970) and again at a similar symposium held in San Francisco in May 1975.

TITLE:

Control of Environmental Impacts from Advanced Energy Sources

AUTHOR:

Evan E. Huges, Edward M. Dickson, and Richard A. Schmidt

ADDRESS:

Office of Research and Development, U.S. Environmental Protection Agency
Washington, D.C. 20460

REFERENCE:

EPA-600/2-74-002, March 1974

SUMMARY:

The technology and the environmental effects associated with the production of energy from some new or advance sources are reviewed. These include solar, geothermal, oil shale, solid wastes, underground coal gasification, and hydrogen energy sources. Projection to the year 2000 of the levels of energy production from the first four of these sources are presented. Levels of these advanced energy sources are projected. Impacts likely to require control measures are identified. Subjects for research and development directed toward control of environmental impacts are recommended. These recommendations are incorporated into a research and development plan. Approximate priority assignments derived from consideration of the timing of development and the importance and degree of definition of the identified environmental effects are given.

This report was submitted in fulfillment of Contract 68-01-0483 by Stanford Research Institute under sponsorship of the Environmental Protection Agency. Work was completed as of March 1974.

TITLE:

Geothermal and Hydrocarbon Regimes, Northern Gulf of Mexico Basin

AUTHOR:

Paul H. Jones

ADDRESS:

Louisiana State University
Baton Rouge, LA

REFERENCE:

Proceedings: First Geopressured Energy Conference, Jun 1975

SUMMARY:

Geothermal heat flow in the Gulf basin is primarily a function of its hydrology. Water expelled from sediments with deepening burial and increasing over-burden load escapes upward and toward the basin margin. Where it moves freely in the hydropressure zone, the basin is relatively cool; but where rapid sedimentation and contemporaneous faulting have retarded water loss from compacting sediments, the interstitial fluid pressure reflects a part of the over-burden load, and the formation waters are superheated and geopressured. The geopressured zone is common below depths of about 3 km (9,600 ft) in the basin, beneath an area of 375,000 km^2 (150,000 mi^2), and extends downward perhaps 15 km (50,000 ft) to the base of Cenozoic deposits.

The upper boundary of the geopressured zone is the most important physical interface in the basin. Across it the head of formation water increases downward from a few hundred to several thousand feet above sea level; the geothermal gradient increases downward from 20° to 40°C/km to 100°C/km or more; the salinity of formation water decreases downward, commonly by 50,000 mg/l or more; and the porosity of shale and sand increases downward by 10 to 25 percent.

Petroleum matures in geopressured clay at 140° to 220°F. Montmorillonite is dehydrated at 180° to 250°F; fresh water released may equal half the volume of the mineral altered. Molecular solubility in fresh water of the hydrocarbons in Gulf basin crude, under geopressured zone conditions, could account for petroleum resources of the basin. Exsolution of petroleum hydrocarbons near the geopressured zone boundary could account for observed occurrences.

This geopressured zone is a natural pressure vessel from which superheated water of moderate salinity could be produced through wells, each yielding millions of gallons a day at pressures of several thousand pounds per square inch, and temperatures above 300°F, with considerable amounts of methane gas in solution.

TITLE:

Hydrogeologic Aspects of Structural Deformation in the Northern Gulf of Mexico Basin

AUTHOR:

Paul H. Jones and Raymond H. Wallace, Jr.

ADDRESS:

Bay Saint Louis, MS

REFERENCE:

Journal Research U.S. Geological Survey, 2 (5), Sept.-Oct. 1974, p. 511-517

SUMMARY:

Resistance of unconsolidated elastic sediments to structural deformation, an inverse function of water content and pore pressure, has no uniform relation to depth of burial in the Gulf of Mexico basin. Deposited rapidly along the northwestern margin of the Gulf Coast geosyncline, sediments of younger deltas leapfrogged older deltas and spilled gulfward upon prodelta and marine clays of older deltas, burying them deeply before they could drain properly in response to compaction stress of overburden load. Contemporaneous gravity faults of major dimension occur gulfward. Margins of deltafront and bodies, reflecting the effect of sediment facies distributions on structure-sand bodies, are more stable than shale masses. Such contemporaneous or growth faults are a most distinctive feature of the of the geology of the Gulf of Mexico basin; they are normal faults with progressive increase in throw with depth and, across which, from upthrown to downthrown block, correlative section thickens greatly. In plan and profile, faulted masses resemble land slides; fault planes are concave gulfward and upward, the dip decreasing with depth. Fault movement rotates the block, causing reversal of dip of beds in the block and sealing the landward ends of included aquifers to discharge of waters of compaction-producing geopressured conditions so common in the Gulf Coastal Plain and Continental Shelf. Early development of geopressure in the block sustains rotational stress. Geopressured water flowing into the fault zone-the easiest escape route-reduces drag and facilitates movement on the fault.

TITLE:

Report on Testing a Geopressured Aquifer in Southern Louisiana

AUTHOR:

O. Karkolits and P.H. Jones

ADDRESS:

McNeese State University
Lake Charles, LA 70601

REFERENCE:

Proceedings on The Second Conference on Geopressured Thermal Energy, Austin, Texas, February 23-25, 1976.

SUMMARY:

There are several unknown factors regarding geopressured geothermal water. One of these is the rate at which water from the sand bed aquifers will flow into the well, which has implications upon the viability of utilizing these wells contain natural gas in solution, but little is known about the quality and amounts. This paper presents an account of the physical characteristics of a test well which will be utilized to answer the above questions, including structural and geological determination of the test bed area and chemical analysis of the well water.

TITLE:

NSTL's Capabilities for Geothermal Systems Verification

AUTHOR:

Fritz R. Krause

ADDRESS:

NASA, Nation Space Technology Laboratories
Bay St. Louis, MS 39520

REFERENCE:

TM-X072728, June 1975

SUMMARY:

NSTL's capabilities for verification of geothermal systems were documented as an input to nation-wide geothermal energy research, development, and demonstration program planning activities by National Aeronautics and Space Administration's Jet Propulsion Laboratory. The industrial water and high pressure gas supplies of the engine test stands might support test beds of hydraulic turbines and hot water pipeline subsystems. NSTL's multi-agency character is structured in a way that allows 18 resident federal and state agencies to contribute their systems verification capabilities to geothermal studies. NSTL's geographical location within the geopressurized zone provides fresh opportunities to open federal field installations to special work study programs which integrate planning and evaluation of turbine and pipeline component tests with other industrial, state, university, and federal geothermal systems verification studies.

TITLE:

Development of the Nation's Geothermal Energy Resources

AUTHOR:

Paul Kruger

ADDRESS:

Division of Geothermal Energy, Energy Research and Development Administration

REFERENCE:

Proceedings of the 2nd Energy Technology Conference

SUMMARY:

Geothermal resources have been heralded as one of the more promising alternate sources of indigenous energy for the United States. Yet the U.S. geothermal electric power industry has grown from 12.5 MWe in 1960 to 396 MWe in 1973, all at a single high-quality geothermal site. The utilization of geothermal waters for heating purposes is insignificant. Forecasts of potential geothermal electric power capacity that can be installed by 1985 have ranged from pessimistic values of less that 2000 MWe to overly optimistic values as high as 400,000 MWe. The Task Force for Geothermal Energy in the Federal Energy Adminsitration Project Independence Blueprint report of November 1974, established a 1985 goal of some 20,000 to 30,000 MWe, the latter value representing an equivalent energy supply of one million barrels of oil per day.

The attainment of this national goal will require an accelerated development of a geothermal industry involving three parallel paths of effort: (1) the discovery, proving, and extraction of geotheraml resources to support the production of more than 5 x 10^2 KWh of electricity over the amortization period of the investment in resource development and power plant construction, (2) the technology to convert the resources as found in its various natural types and qualities into electric and thermal power production, and (3) the removal of institutional constraints to the development of an economic and environmentally-acceptable industry.

TITLE:

The Economic Generation of Electricity from Moderate Temperature Geothermal Resources

AUTHOR:

J.F. Kunze, J.F. Whitbeck, R.H. Dart

ADDRESS:

Idaho National Engineering Laboratory, Idaho Falls, Idaho

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering
Conference Proceedings 1976, Vol. I.

ABSTRACT:

The large energy potential of the medium temperature geothermal resource (∿120-170°C) makes it attractive for power production. The lower efficiency inherent with lower source temperatures apriori leads to the conclusion that it will be difficult to show favorable economics. However, there are basic differences in the engineering approcaches that can be applied which favor the use of moderate temperatures. These approaches which are being evaluated on the Raft River geothermal resource (∿150°C) and the economics of power production from this resource, compared with more conventional thermal power systems, are presented in this paper.

TITLE:

Application of the Stretford Process for H_2S Abatement at the Geysers Geothermal Power Plant

AUTHOR:

J. Laszlo

ADDRESS:

Pacific Gas and Electric Co., San Francisco, CA

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering Conference Proceedings, 1976, Vol. I

ABSTRACT:

Superheated steam occurs naturally, 150-3,000 meters (m) (500-10,000 feet) underground in the area know as The Geysers in Northern California, 130 kilometers (km) (80 miles) north of San Francisco. Produced by wells drilled by techniques very similar to those used in natural gas production, the steam is collected and is piped to electric generating plants. Electric power is generated by utilizing the naturally occurring steam in low pressure, steam turbine generators. As a by-product of power generation, small amounts of hydrogen sulfide (H_2S) are released to the atmosphere. In low concentrations H_2S has an offensive sulfurous odor. During certain weather conditions the low level H_2S content in the ambient air can be a definite nuisance as well as a potential violation of air pollution regulations. Pacific Gas and Electric Company, the owner and operator of The Geysers Power Plants has for several years carried out extensive research on a number of different methods to reduce H_2S emissions originating from power generating equipment. For the latest three generating units to be completed by 1978 and 1979, the Stretford Process H_2S abatement for the removal of H_2S from coal gas is planned. It proved to be equally suitable for desulfurization of a variety of other gas streams, such as refinery gases, synthetic gas and natural gas as well as hydro-carbon liquids. Extensive re-design of the power plant equipment is required in order to facilitate the application of the Stretford Process at the Geysers however, significant reduction of total H_2S emissions is expected as a result.

TITLE:

A Description of Imperial Valley, California for the Assessment of Impacts of Geothermal Energy Development

AUTHOR:

David Layton and Donald Ermak

ADDRESS:

Lawernce Livermore Laboratory
University of California
Livermore, CA 94550

REFERENCE:

UC66 UCRL 52121

SUMMARY:

Impending geothermal development in the Imperial Valley of California has raised concern over the possible impacts of such development. As an initial step in impact assessment of geothermal projects, relevant features of the valley's physical and human environments are described. Particular attention is placed on features that may either influence development or be affected by it. Major areas of consideration and biological resources), economic, fiscal, and social characteristics of Imperial County, and geothermal laws.

TITLE:

Extracting Energy From Hydraulically - Fractured Geothermal Reservoirs

AUTHOR:

R.D. McFarland and H.D. Murphy

ADDRESS:

Los Alamos Scientific Laboratory, Los Alamos NM 87545

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering Conferences Proceedings
1976 Vol. I

SUMMARY:

In the absence of fluid "short circuiting" the rate at which energy can be produced from a single hydraulic fracture in hot rock is limited only by the size of the fracture and the low thermal conductivity of most types of rock. The extent of "short circuiting" is determined by the location of the reservoir inlet and outlet and by the ratio of the Grashof and Reynolds numbers. Since the fracture gap width continuously changes due to thermal contraction of the rock, fractures that are intially "short circuited" can eventually evolve, due to buoyancy effects, eddy-like flow patterns, so that more of the heat transfer area in the fracture is accessible to the flowing water. In this manner, significant quantities of energy can be extracted from hydraulic fractures--even when the placement of the inlet and outlet is far from optimum; and the anticipated, beneficial effects of thermal stress cracking are neglected.

TITLE:

Economic and Engineering Implications of the Project Independence 1985 Geothermal Energy Output Goal and the Associated Sensitivity Analysis

AUTHOR:

Asok V. Mukhopadhyay

ADDRESS:

Jet Propulsion Laboratory
Pasadena, California 91103

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering Conference Proceedings, 1976, Vol. 1.

SUMMARY:

The present paper combines the Project Independence 1985 geothermal output goal, via., 20,000 megawatts (MW) with the available time-line data for a typical geothermal energy plant in order to establish requirements, such as, the rate of lease award, exploration, production drilling, plant construction resource expenditure/supply necessary to meet such an adopted goal. Though the specific time-line used in the study is based on detailed discussions with federal, state and industry representatives, time-lines by their very nature can vary drastically with state and local regulations, the nature of the specific reservoir under development and other factors. Similarly, the exploratory and drilling rig efficiencies and the unit costs associated with the various phases of geothermal development depend on today's framework of technological, environmental and economic constraints. Thus, it is highly imperative to determine the sensitivity of the needed rates of development to various technical, economic and institutional parameters; it is equally significant to investigate the sensitivity with respect to variations of the goal magnitude, the goal rate and the goal date from the nominal values set out in Project Independence. A computer program has been written, so that the results of such a sensitivity analysis can be quickly obtained as printed and plotted output with the least expense.

TITLE:

An Engineering Feasiblity Study of Using Low Temperature Geothermal Sources in Colorado

AUTHOR:

1. L.W. Nannen (deceased), 2. F. Krieth and R.E. West

ADDRESS:

1. Environmental Consulting Services, Inc., Boulder CO
2. Chemical Engineering Department, University of Colorado, Boulder, CO

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering Conferences Proceedings 1976 Vol. I.

SUMMARY:

The technical and economic feasibility of using low temperature geothermal sources in Colorado was investigated. It was projected that several of the known sources could be used to heat buildings and water in district-type projects at costs between 2 and 5 dollars per Gj delivered. The technology necessary to use geothermal sources for low temperature applications exists. Not enough is known about the thermal, chemical and geological characteristics of the several geothermal sources in Colorado to determine whether they are suitable for electric power generation. Nonetheless, several should be suitable for applications which can reduce the demand for power and natural gas. It is recommended that an exploratory well and demonstration heating project be undertaken at Glenwood Springs, CO.

TITLE:

Interdisciplinary Planning for Geothermal Development at the County Level.

AUTHOR:

David E. Pierson

ADDRESS:

Director of Public Works, Imperial County, El Centro, CA 92243

SUMMARY:

A National Science Foundation grant to the County of Imperial is funding a study for planning for geothermal development at the County level, the outcomes of which will be a geothermal element of the County General Plan and a research methodology for utilization by other government entities. The research work is being subcontracted to two universities. The project results must withstand public accountability in the form of public hearings, and acceptance by the County Planning Commission and the County Board of Supervisors. The subject areas addressed by the study are: resource assessment, engineering, geography, environment, economics, sociology and political/legal. A status report of research results is included.

TITLE:

Electric Utility Companis and Geothermal Power

AUTHOR:

Donna Shirley Pivirotto

ADDRESS:

Jet Propulsion Laboratory
Pasadena, CA

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering Conference, Proceedings
1976, Vol. I

SUMMARY:

The electric utility industry is currently the primary potential market for geothermal energy. Engineers concerned with the design of geothermal power plants, electric conversion equipment or exploration and development technology must therefore consider utility industry requirements which may affect such designs. This paper discusses the needs of the electric utility industry as these needs impact the development of geothermal energy. The paper describes the electric utility industry, its structure, the forces which influence utility companies and their relationship to geothermal energy. Considerations necessary to a federal program for geothermal development are presented, and a strategy for federal stimulation of utility investment in geothermal energy is suggested. The needs for demonstration of commercial feasibility of hydrothermal resources and for reservoir engineering technique development are pointed out. Possibilities are discussed for stimulating utility investment through financial incentives, amelioration of institutional barriers, and technological improvements.

TITLE

Pressure Drawdown and Buildup Analyses in Geothermal Reservoirs

AUTHOR:

Larry Rice

ADDRESS:

Systems, Science and Software, P.O. Box 1620, LaJolla, CA 92038

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering Conference Proceedings
1976, Vol. I

SUMMARY:

Classical well analyses were performed using Systems, Science and Software's Quasi-Active Geothermal Reservoir simulator (QUAGMR). QUAGMR solves the equations of heat flow and unsteady Darcian fluid flow in one, two or three space dimensions and is capable of handling a single phase liquid-water system or a multiphase liquid/vapor system. Pressure drawdown and buildup well tests are performed to acquire permeability data for the reservoir. Classical interpretation assumes that only a single phase is flowing during the test. This assumption can lead to dramatic errors in the permeability data, if in fact, there is multiphase flow. One and two-dimensional problems were formulated with single and multiphase flow during the well test. In the single phase problems, very good agreement with the classical theory was demonstrated. However, in the multiphase problems, the classical interpretation led to gross errors in the permeability data. These errors could lead to mismanagement of the reservoir engineering of the geothermal field.

TITLE:

Power Production from High Temperature Geothermal Waters

AUTHOR:

I. Sheinbaum

ADDRESS:

I. Sheinbaum Co., Pasadena, CA

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering Conference Proceedings
1976, Vol. 1.

SUMMARY:

It appears that the first electrical power production from a liquid-dominated geothermal reservoir to be developed in the United States will be processed from the high salinity, high temperature reservoir. There are currently two recognized state-of-the-art processes and one experimental process for the conversion of high temperature geothermal waters into electric power. The adaptability, the efficiency, and the relative costs of the Direct Contact Binary Cycle (1) for the conversion of high temperature geothermal resources into power, will be explored in this paper and compared with the existing processes. Two types of hot geothermal waters are evaluated.

a. High temperature, low salinity, no noncondensables.
b. High temperature, higy salinity, with noncondensalbes.

The Direct Contact Binary Cycle can be characterized as highly efficient, flexible, and very economical when compared to the other power conversion processes. The process is especially suitable for handling high salinity and precipitating brines.

TITLE:

Geothermal Energy in Hawaii--Hydrothermal Systems

AUTHOR:

John W. Shupe, Robert M. Kamins, Paul C. Yuen

ADDRESS:

University of Hawaii, Honolulu, Hawaii USA

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering
Coverence Proceedings, 1976, Vol. I

ABSTRACT:

The Hawaii Geothermal Project (HGP) was organized to focus the resources of the University, the State and the County of Hawaii on the identification, generation, and utilization of geothermal energy on the Big Island of Hawaii. The research program involved an interdisciplinary team of researchers from throughout the University system which conducted scientific investigations on short-range exploratory and applied technology tasks to assist in the early development of any conventional hydrothermal systems in Hawaii, as well as long-range studies of a more basic nature. This paper is a general case study or progress report on Phase I, the exploratory geophysical survey program, with supporting activity in engineering, socioeconomic, and environmental programs; and Phase II, the research drilling program. Drilling for the initial well got underway in December 1975 and continued through April 1976 to a depth of 1964.4 meters (6445 feet), at a site established through data obtained in Phase I. Preliminary results and projections on the potential of geothermal power for Hawaii are presented.

TITLE:

Direct Application of Geothermal Energy

AUTHOR:

R.C. Schmitt, R.J. Schultz, J.L. Griffith, Dr. W.S. Brown

ADDRESS:

Idaho National Engineering Laboratory, Idaho National Engineering Laboratory,
ERDA-Idaho Operation Office, Dean of Engineering, University of Utah

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering Conference Proceedings
1, 815 (1976).

SUMMARY:

The direct application of geothermal energy commenced in the United States in the late 1800's, but utilization has developed on a very limited scale. The U.S. Energy Research and Development Administration's Idaho National Engineering Laboratory has engaged in expanding the scope of applications and in stimulating the utilization of the low-to-intermediate temperature hydrothermal sources.

The techniques currently being used to stimulate growth of the industry include the proposed Geothermal Loan Guarantee Program, compilations of engineering and economic analyses, resource/utilization surveys, demonstration or field verification unit development, and various technology transfer mechanisms.

Geothermal energy can be used for almost any activity requiring large quantities of heat at relatively low temperatures. Several types of demonstration and field verification projects have been initiated by the INEL to illustrate this viability. These projects areas are central space heating districts, large building space heating using low temperature resources, industrial food processing, agricultrual uses and aquaculture. Information which is provided on these project areas includes process type, location, technical problems and goals, and status and schedules.

TITLE:

Environmental Aspects of Geothermal Energy Development Salton Sea/Imperial Valley Area

AUTHOR:

Kathy Tonnesen

ADDRESS:

Lawerence Livermore Laboratories
University of California
Livermore, CA

REFERENCE:

UCID-16717

SUMMARY:

Geothermal energy, the natural heat of the earth is currently the subject of a significant amount of investigation, experimentation and development as a source of potentially large amounts of electrical energy. These projects are concerned with three different types of geothermal energy:

1) Dry steam geothermal - being developed at Geysers, California
2) Hot, dry rock - which is the resource under investigation by Los Alamos Scientific Laboratory, Lawrence Berkeley Laboratory, and Batteile PNW Laboratory. This approach involves deep dry rock fracturing and subsurface heating if injected waters, and
3) Hot brines - which are the hot, often highly saline fluids such as those which underlie the Imperial Valley of California.

TITLE:

Energy From the West: A Progress Report of a Technology Assessment of Western Energy Resource Development Vol. I

AUTHOR:

I.L. White

REFERENCE:

PB 271 752 (NTIS)

SUMMARY:

This is a progress report of a three year technolgoy assessment of the development of six energy resources (coal, geothermal, natural gas, oil, oil shale, and uranium) in eight western states (Arizona, Colorado, Montana, New Mexico, North Dakota, South Dakota, Utah, and Wyoming) during the period from the present to the year 2000. Volume I describes the purpose and conduct of the study, summarizes the results of the analyses conducted during the first year, and outlines plans for the remainder of the the project.

TITLE

Energy From the West: A Progress Report of a Technology Assessment of Western Energy Resource Development Vol. II

AUTHOR:

I.L. White

REFERENCE:

PB 271 752 (NTIS)

SUMMARY:

This is a progress report of a three year technology assessment of the development of six energy resources (coal, geothermal, natural gas, oil, oil shale, and uranium) in eight western states (Arizona, Colorado, Montana, New Mexico, North Dakota, South Dakota, Utah, and Wyoming) during the period from the present to the year 2000.

In Volume II, more detailed analytical results are presented. Six chapters report on the analysis of the likely impacts of displaying typical energy resource development technologies at sites representative of the study area. A seventh chapter focuses on the impacts likely to occur if western energy resources are developed at three difference levels from the present to the year 2000.

TITLE:

Energy From the West: A Progress Report of a Technology Assessment of Western Encergy Resource Development Vol IV.

AUTHOR:

I.L. White

REFERENCE:

PB 271 752 (NTIS)

SUMMARY:

This is a progress report of a three year technology assessment of the developement of six energy resources (coal, geothermal, natural gas, oil, oil shale, and uranium) in eight western states (Arizona, Colorado, Montana, New Mexico, North Dakota, South Dakota, Utah, and Wyoming) during the period from the present to the year 2000.

The Fourth Volume presents two appendices, on air quality modeling and energy transportation costs.

TITLE:

Assessment of Geothermal Resources of United States, 1975.

AUTHOR:

D.E. White and D.L. Williams, Editors

ADDRESS:

U.S. Geological Survey
National Center
Reston, Virginia 22092

REFERENCE:

Geological Survey Circular 726

SUMMARY:

The appraisal of the geothermal resources of the United States presented here is as factual as we can provide from available data. Much effort has been made in each individual chapter to specify the uncertainties and assumptions involved in each estimate; we urge that these uncertainties be kept in mind. The estimates should be regarded as first attempts that will need to be updated as new information becomes available.

This assessment consist of two major parts: (1) estimates of total heat in the ground to a depth of 10 km and (2) estimates of the part of this total heat that is recoverable with present technology, regardless of price. No attempt has been made to consider most aspects of the legal, environmental, and institutional limitations in exploiting these resources.

TITLE:

Problems and Opportunities in Geothermal Energy

AUTHOR:

Eric H. Willis

ADDRESS:

Energy Research and Development Administration

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering Conference Proceedings, 1, 693 (1976).

ABSTRACT:

This article discusses the ERDA's Geothermal Energy Program, its strategy, the criteria by which the priorities are ordered, and what the program hopes to accomplish. The objective is to provide the Nation with a viable energy option by helping to develop and demonstrate the substantial geothermal resources with which the country is endowed.

TITLE:

Geothermal Studies in Northern Nevada

AUTHOR:

Harold A. Wollenburg

ADDRESS:

Lawrence Berkely Laboratory, University California, Berkely, CA 94720

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering
Conference Proceedings 1976. Vol. I

SUMMARY:

The Lawrence Berkeley Laboratory (LBL) and University of California (UCB), under the auspices of the U.S. Energy Research and Development Administration are conducting field studies at potential geothermal resource areas in north-central Nevada. The goal of the LBL-UCB program is to develop and evaluate techniques for the assessment of the resource potential of liquid-dominated systems. Field studies presently being conducted in northern Nevada incorporate an integrated program of geologic, geophysical, and geochemical surveys leading to heat flow measurements, and eventually to deep (1.5-2 km) confirmatory drill holes. Techniques evaluated include geophysical methods to measure contrasts in electrical resistivity and seismic parameters. Geochemical studies have emphasized techniques to disclose the pathways of water from its meteoric origin into and through the hydrothermal systems. Geochemical and radiometric analyses also help to provide a baseline upon which the effects of future geothermal development may be superimposed.

TITLE:

Geothermal Energy - Final Task Force Report

AUTHOR:

Under Direction of National Science Foundation

ADDRESS:

Federal Energy Administration
Washington, D.C.

REFERENCE:

Project Independence Blueprint
November, 1974

SUMMARY:

Geothermal energy is becoming a small but viable contributor to U.S. energy supplies. However, its development must be greatly accelerated if it is to contribute to meeting urgent domestic energy needs on a significant scale.

Geothermal waters have been used since ancient times; they have been used for municipal heating in Iceland since the 1930's and are being used to a small extent in the United States. Electric power production from geothermal energy began in 1904 at the Larderello field in Italy. Today, somewhat more than 1,000 MWe is being generated in the world.

The U.S. Geothermal resource base has been compared favorably with present oil and gas reserves. It is believed that the most readily exploitable geothermal resources are located in the western third of the U.S. Their development could have considerable impact on meeting the power requirements of the Nation. For instance, it has been estimated that the Imperial Valley in California could sustain a generating capacity of as much as 100,000 MWe for 50 years. Costs of electricity produced from geothermal energy are estimated to be lower than those associated with fossil and nuclear fuels. For example, electric power derived from geothermal resources could be competitive with oil at $4 per barrel.

Only one geothermal resource, dry steam, is presently being used to produce power in the Unites States, generating more than 400 MWe at The Geysers in California at a capital investment cost of $100 million annually. There are no other known sources of dry steam in the U.S. except those in Yellowstone National Park.

TITLE:

Economic Optimization of Binary Fluid Cycle Power Plants for Geothermal Systems

AUTHOR:

Ronald A. Walter and Stephen W. Wilson

ADDRESS:

Battelle, Pacific Northwest Laboratories, Richland, WA

REFERENCE:

Eleventh Intersociety Energy Conversion Engineering Conference Proceedings, 1976, Vol. I.

SUMMARY:

An analytical model called GEOCOST has been constructed and used to study the design, performance and cost of geothermal power plants using the binary fluid cycle. The GEOCOST computer program simulates all the major components of a geothermal system and calculates the cost of energy production by equating the present worth of revenues and expenses including investment return over the economic life of the plant and/or reservoir. The characteristics of the binary fluid cycle power plant are determined for a variety of geothermal resources, working fluids, and cycle types. An optimization technique based upon the maximum use of available energy in the geothermal fluid is generated, and results of this optimization technique are compared with computed cost data for a variety of binary power plants.

TITLE:

Resource Technology and Environment at the Geysers

AUTHOR:

Oleh Weves, Karen Lsao, and Byron Wood

ADDRESS:

Energy & Environment Division
Lawerence Barkeley Laboratory
University of California
Berkeley, CA 94720

REFERENCE:

LBL-5231 UC-66 TID-4500-R65

SUMMARY:

The widespread public debate over further geothermal development at the Geysers and in Lake County has created a general interest in the Geysers development and their environmental consultants have an even more pressing need for information about it. Up until now, this information has only been available in such scattered and often highly technical form that only those who actually work in the geothermal energy area have had fuctional access to it.

This report is intended to remedy that lack by providing a comprehensive and readable account of the Geysers development, its environmental impacts, and the state of development of the technology for mitigating them. It is not intended to be an Environmental Impact Report; rather, it is intended to complement the numerous EIR's (and EIS's, DES's, etc.) which have dealt with geothermal development in the area. EIR's are very site specific and, because they are written mostly by environmental scientists, they focus much more on the local environment than upon the nature of the resource, the technology, or other such generic questions. Our report is mostly about the resource, the technology, and its generic environmental impacts. We are sure that it will be put to good use as a source document by those who prepare EIR's. Its companion report by Vollintine, Sathaye, and Kunin (1977) is likewise intended to serve as a source document and data base for the study of the socioeconomic impacts of geothermal development in Lake County.

TECHNICAL REPORTS:
POTENTIAL QUALITY CONTROL STANDARDS

TITLE:

The Synthesis of Benz[α]Anthracene

AUTHOR:

R.U. Ahmed, T. Rangarajan, *E.J. Eisenbraun, G.W. Keen, and M.C. Hamming

ADDRESS:

*Department of Chemistry, Oklahoma State University, Stillwater, OK 74074

REFERENCE:

Organic Preparations and Procedures Int. 7 (6), 267-270 (1975)

SUMMARY:

Benz[α]anthracene, a carcinogenic polynuclear aromatic hydrocarbon widely distributed in the environment, is an important reference hydrocarbon in pollution studies. Consequently a direct and reliable synthesis was developed. 2-(1-Naphtholy)benzoic acid, prepared from the reaction of naphthalene and phthalic anhydride in the presence of ammonium chloride, was cyclized to 1,2-Benzanthraquinone using PPA as the catalyst. The 1,2-Benzanthraquinone was reduced by the action of aluminum tricyclohexoxide to the desired Benz[α]anthracene. The crude product was separated and purified by complexing with picric acid.

TITLE:

Polynuclear Aromatic Hydrocarbons in Coal Identification By Their X-Ray Excited Optical Luminescence

ADDRESS:

Ames Laboratory and Department of Chemistry
Iowa State University
Ames, Iowa 50011

SUMMARY:

Several polynuclear aromatic hydrocarbons have been isolated from raw coal and detected by their characteristic X-ray excited optical luminescence spectra.

Potential Quality Control Standards

TITLE:

The Synthesis of 1,2,3,7,8,9-Hexahydrodibenzo[ded,mno] Chrysene and the use of Hydroiodic Acid - Red Phosphorous in the Deoxygenation of Ketones

AUTHOR:

L. Ansell, T. Rangarajan, W. Burgess, E.J. Eisenbraun*, G.W. Keen, and M.C. Hamming

ADDRESS:

*Department of Chemistry, Oklahoma State University, Stillwater, Okla. 74074

SUMMARY:

In this paper we describe the synthesis of 1,2,3,7,8,9-hexahydrobenzo[def,mno]chrysene, a new hydrocarbon, from the reduction of dibenzo-[def,mno] phosphorus (DI-P_4) reduction method, which was used in synthesizing the desired product, appears to be the most practical method for deoxygenation of some benzylic ketones.

Potential Quality Control Standards

TITLE:

Synthesis of 2-(1-Naphthylmethyl)-3,4-Dihydronaphthalene, 2-(1-Naphthylmethyl)-1,2,3,4-Tetrahydronaphthalene, 7a,8,9,13b-Tetrahydro-7H-Dibenz-[a,kl]Anthracene, and5,6-Dihydro-4H-Dibenz]a,kl]Anthracene

AUTHOR:

L.L. Ansell, T.E. Webb, J.W. Burnham, E.J. Eisenbraun*, M.C. Hamming and G.W. Keen

ADDRESS:

Department of Chemistry, Oklahoma State University, Stillwater, Okla. 74074

REFERENCE:

Organic Preparations and Procedures Int. 8(3), 125(1976)

SUMMARY:

This paper describes the synthesis of three new hydrocarbons - 2-(1-naphthylmethyl)-3,4-dihydronaphtalene, 2-(1-naphthylmethyl)-1,2,3,4-tetrahydronaphthalene, and 7a,8,9,13b-tetrahydro-7H-dibenz[a, kl]anthracene-all based on an initital aldol condensation of 1-tetralone and 1-naphthaldehyde to produce 3,4-dihydro-2-(1-naphthlmethyl)-1(2H)-naphthaleone. Also described is a procedure for converting the latter of the three new hydrocarbons to 5,6-dihydro-4H-dibenz[a,kl]anthracene by the action of Pd/C catalyst and heat.

TITLE:

Spiro Hydrocarbons and Dibenzo[c,p]chrysene from 1-Tetralone

AUTHOR:

John W. Burnham, Robert G. Melton, and Edmund J. Eisenbraun*

ADDRESS:

*Department of Chemistry, Oklahoma State University
Stillwater, Oklahoma 74074

REFERENCE:

Journal of Organic Chemistry, 38, 2783 (1973).

SUMMARY:

1-Tetralone and phenylmagnesium bromide yield 3,4-dihydro-1-phenylnaphthalene and 1',2',3',4',5,6-hexahydrospiro[7H-benzo[c]fluorene-7,1'-naphthalene]. The latter is formed in a series of reactions involving the self-condensation of 1 to 2-(3,4-dihydro-1-naphthyl)-3,4-dihydro-1(2H)-naphthaleone, addition of Grignard reagent, acid-catalyzed dehydration to the diene, and its subsequent cyclization. The latter was dehydrogenated with Pd/C to 1',2',3',4'-tetrahydrospiro[7H-benzo[c]fluorene-7,1'-naphthalene] and then was converted to dibenzo]c,p] chrysene by heating in the presence of Pd/C and sulfur.

TITLE:

USEPA Coal Leachate Project R803952-01-1

AUTHOR:

R.M. Carlson and R. Caple

ADDRESS:

University of Minnesota, Duluth

SUMMARY:

A major improvement has been made in the development of a reliable method for the quantitative analysis of polynuclear aromatic hydrocarbons (PAH)'s at the ppt level. This methodology, involving a combination of HPLC and GLC separation techniques, should find universal application to the identification of PAH's in aqueous samples and to further enable us to pursue our bioaccumulation studies of these potential carcinogens in fish. Experimental procedure for the application of this method is given, along with some experimental results. Results from the application of this technique in the study of the toxicity and bioaccumulation of the leachate on fish is also cited and discussed.

TITLE:

Trace Impurities in Fuels by Isotope Dilution Mass Spectrometry

AUTHOR:

J.A. Carter, R.L. Walker, J.R. Sites

ADDRESS:

Oak Ridge National Laboratory
P. O. Box Y
Oak Ridge, Tennessee 3783-

REFERENCE:

Advances in Chemistry 141, 74, 1975

SUMMARY:

Spark source (SSMS) and thermal emission (TEMS) mass spectrometry are used to determine ppb to ppm quantities of elements in energy sources such as coal, fuel oil, and gasoline. Toxic metals--cadmium, mercury, lead and zinc--may be determined by SSMS with an estimated precision of ±5%, and metals which ionize thermally may be determined by TEMS with an estimated precision of ±1% using the isotope dilution technique. An environmental study of the trace element balance from a coal-fired steam plant was done by SSMS using isotope dilution to determine the toxic metals and a general scan technique for 15 other elements using chemically determined iron as an internal standard. In addition, isotope dilution procedures for the analysis of lead in gasoline and uranium in coal and fly ash by TEMS are presented.

TITLE:

NO_x Standards of Performance for New Lignite-Fired Steam Generators

AUTHOR:

John P. Christiano and Richard V. Crume

ADDRESS:

U.S. Environmental Protection Agency, Research Triangle Park, NC

REFERENCE:

Technology and Use of Lignite Symposium, Grand Forks, ND
(May 1977) GFERC/IC-77/1 (page 274).

SUMMARY:

A standard of performance limiting NO_x emissions from large lignite-fired steam generating units was proposed for public comment by the Enviornmental Protection Agency in December 1976. The supporting information and rationale for the standard are discussed.

The standard of 260 nanograms of NO_x per joule (ng/J) heat input (0.6 lb/10^6 Btu) would, in effect, ban the use of cyclone-fired boilers. Since some of the utilities firing lignite have claimed that cyclone-fired units can burn lignite more reliably than pulverized-fired units, EPA solicited comments and factual information to assess the relative costs and reliability of cyclone- and pulverized fuel-fired steam generators. Information submitted in response to EPA's request is presented.

EPA also requested comments on the effects of a lower standard on the boiler manufacturing industry and on the electric utility industry. One boiler manufacturer can likely meet a standard of 220 nanograms per joule (0.5 lb/10^6 Btu), while the other manufacturers may have difficulty meeting the proposed standard of 260 ng/J. Comments received on the effect of removing the competitive balance among boiler manufacturers and removing the option of the utilities to obtain a competitive bid are also discussed.

TITLE:

Acid Mine Drainage Abatement Measures for Selected Areas within the Susquehanna River Basin

AUTHOR:

Gannett Fleming Corddry and Carpenter, Inc.

ADDRESS:

Harrisburg, PA

REFERENCE:

PB-220 150/0 (NTIS)

SUMMARY:

A major source of pollution in the Susquehanna River Basin having a detrimental effect on water quality is the mine drainage resulting from coal mining operations in Pennsylvania. Investigations and studies were performed in five designated coal mining areas located in the basin to establish (1) the causes and extent of mine drainage, (2) the various mine drainage pollution abatement plans that are available and capable of meeting current discharge limitations as well as costs associated therewith, and (3) an abatement plan which should be implemented. The findings, conclusions and recommendations resulting from the investigations and studies are discussed in the report.

TITLE:

Soxhelt Extraction as a Safety Feature in the Synthesis of Polynuclear Aromatic Hydrocarbons

AUTHOR:

K.D. Cowan and E.J. Eisenbraun

ADDRESS:

Department of Chemistry, Oklahoma State University, Stillwater, OK 74074

REFERENCE:

Chemistry and Industry 46 (1975)

SUMMARY:

The construction and operation of a safety modified Soxhlet Extraction apparatus useful in the synthesis of carcinogenic hydrocarbons is described. The addition of the safety features herein described is necessary to contain surges of boiling liquid which may result from bumping in a superheated solution.

TITLE:

Synthesis of 2,3-Dihydro-3-methyl-1-(2-Naphthyl)-1H-Benz[e]Indene and 1,1,3-Trimethyl-3-Phenylindan

AUTHOR:

W.P. Duncan, E.J. Eisenbraun*, A.R. Taylor, and G.W. Keen

ADDRESS:

*Department of Chemistry, Oklahoma State University, Stillwater, OK 74074

REFERENCE:

Organic Preparations and Procedures Int. 7(5), 225(1975)

SUMMARY:

This paper describes the formation of *cis* - and *trans* - 2,3-dihydro-3-methyl-1-(2-naphthyl)-1H-benz[e]indene by the cyclization of either 1-(2-Naphthyl)-ethanol or 2-Vinylnaphthalene. Both compounds readily cyclized to the desired products through the use of PPA and also by amberlyst-15 sulfonic acid resin which gave slightly better yields. Also described is a method of producing 1,1,3-trimethyl-3-phenylindan from α-methyl-styrene, again by treatment of the latter with amberlyst-15 sulfonic acid resin.

TITLE:

Sodium-Ethylenediamine Reductive Dimerization of Naphthalene to 5,6,7,12,13,14-Hexahydro-5,13:6, 12-dimethanodibenzo[a,f]cyclodecene

AUTHOR:

E.J. Eisenbraun,* L.L. Ansell, T.K. Dobbs, L.E. Harris, D.V. Hertzler,
P.H. Ruehle, John E. Burks, Jr., and Dick van der Helm

ADDRESS:

*Department of Chemistry, Oklahoma State University, Stillwater, Okla. 74074

REFERENCE:

Journal of Organic Chemistry, 41, 2910 (1976).

SUMMARY:

Crystallographic studies of the $C_{20}H_{20}$ reduced dimer, mp 179-180°C, obtained from treatment of naphthalene with sodium and ethylenediamine showed the hydrocarbon to be the title compound. This analysis allowed H NMR absorption assignments. Other properties of 1 and its oxidation products are reported.

TITLE:

Stream Pollution by Coal Mine Drainage in Appalachia

AUTHOR:

Federal Water Pollution Control Administration

ADDRESS:

Cincinnati, Ohio, Ohio Basin Region

REFERENCE:

PB-230 022/6 (NTIS)

SUMMARY:

The report is intended to serve as a summary reference concerning the occurrence and sources of coal mine drainage pollution in Appalachia.

TITLE:

Brown Coal Gasification with Oxygen or Air in the High-Temperature Winkler-Gasifier

AUTHOR:

F.H. Franke and E. Pattas

ADDRESS:

Rheinishe Braunkohlenwerke AG, Cologne (FRG)

REFERENCE:

Presented at the Lignite Symposium, Grand Forks, North Dakota, May 18-19, 1977

SUMMARY:

In 1922 the patent concerning a fluidized-bed reactor for coal gasification was first applied for by Mr. F. Winkler. This unit showed market advantages compared with the gasification processes known until that date. On the basis of the simple gasifier concept which can be easily operated a substantial increase in capacity could be achieved entailing the erection of a number of large-scale industrial plants.

From 1956 up to the end of 1964 two fluidized-bed generators with a capacity of 1 7000 Nm^3/h, each, were operated by the Union Rheinische Braunkohlen Kraftstoff AG - a subsidiary of the Rheinische Braunkohlenwerker AG - for the production of synthesis gas. In these plants Rhenish brown coal was gasified.

TITLE:

Spectral Techniques in Structural Studies

AUTHOR:

R.A. Friedel and A.G. Sharkey

ADDRESS:

Pittsburgh Energy Research Center, U.S. Bureau of Mines,
Pittsburgh, PA

REFERENCE:

Research/Development 30 (1973)

SUMMARY:

Information for characterization of matter can increase exponentially with the number of complementary spectral techniques used. Combination of infrared, laser-Raman, uv-visible, MS, NMR, ESR, Mossbauer, x-ray and other methods are described.

TITLE:

Determination of Trace Metals in Power Plant Effluents

AUTHOR:

J.C. Guillaumin

ADDRESS:

The Detroit Edison Company, 2000 Second Avenue, Detroit, MI 48226

REFERENCE:

Atomic Absorption Newsletter, Vol. 13, No. 6, 135 (1974).

SUMMARY:

Flameless atomic absorption spectophotometry was used to determine the level of 12 trace metals in power plant effluents and inlet water samples. The metals determined include: arsenic, calcium, cadmium, chromium, copper, iron, mercury, maganese, nickel, lead, selenium, and zinc.

Inlet and outlet samples were obtained using a specially modified sequential sampler to obtain 24 one-hour composite samples per day. Each plant was sampled for one-to-three-week period. Over 20,000 individual analysis were performed on over 1000 samples from 11 plant locations. Sampling procedures, sample container preparation and storage are examined. Analytical procedures are detailed and precision and recovery data are given.

TITLE:

Solid and Gaseous Fuels

AUTHOR:

E.A. Hattman, H. Schultz and C. Ortuglio

ADDRESS:

U.S. Department of Interior, Bureau of Mines, 4800 Forbes Avenue, Pittsburgh,
PA 15213

REFERENCE:

Anal. Chem., 45 (5), 345 R (1973).

SUMMARY:

This is the 13th of the series of reviews on methods of sampling, analyzing, and testing solid mineral and gaseous hydrocarbon fuels. The present review covers a 2-year period ending on October 1, 1972, and follows the general pattern of the previous reviews. A definitive bibliography of 429 references is included and topics such as gas chromatography, mass spectrometry and IR, analysis of sulfur compounds, potentiometric and colorometric methods, petrography, inorganic constituents, in coal and coal ash, coking processes and coke testing, etc. are discussed at some length.

TITLE:

Rehabilitation of Streams Receiving Acid Mine Drainage

AUTHOR:

Herricks, Edwin, E., Cairns, John, Jr.

ADDRESS:

Virginia Polytechnic Institute and State University, Blacksburg,
Water Resources Research Center, Washington, D.C.

REFERENCE:

PB-237 268/8ST (NTIS)

SUMMARY:

The effects of short term low pH and long term acid mine drainage (AMD) stress were studied in relation to recovery and restoration of aquatic macrobenthic communities. Experimental acid additions were made to a healthy productive stream, reducing pH from 8.0 to 4.0 for 15 minutes. Diversity and density were decreased. Recovery was related to downstream drift of recolonizing organisms; full recovery occurred within 19 to 28 days with density and diversity equaling prestress values. A second study was made to observe drive-borne recolonizing organisms.

TITLE:

EPRI Research Program: Focus on Lignite

AUTHOR:

George R. Hill

ADDRESS:

Electric Power Research Institute
Palo Alto, California

REFERENCE:

Technology and Use of Lignite Symposium
Grand Forks, ND, May 1977 (GFERC/IC-77/1) page 123

ABSTRACT:

Environmental problems and work on particulate removal and reduction of SO_4 and NO_4 emissions are reviewed with emphasis on application for use with low-rank coals. A high intensity ionizer prior to an electrostatic precipitator has shown promise for improved removal; bag filters are also being tested.

TITLE:

Control of Environmental Impacts from Advanced Energy Sources

AUTHOR:

Evan E. Hughs, Richard M. Dickson, Richard A. Schmidt

REFERENCE:

EPA-600/2-74-002

SUMMARY:

The technology and the environmental effects associated with the production of energy from some new or advanced sources are reviewed. These include solar, geothermal, oil shale, solid wastes, underground coal gasification, and hydrogen energy sources. Projections to the year 2000 of the levels of energy production from the first four of these sources are presented. Environmental impacts on air quality, water quality, and land uses are derived per unit of energy produced. Levels of pollutant emissions and other environmental effects of the development of these advanced energy sources are projected. Impacts likely to require control measures are identified. Subjects for research and developemnt directed toward control of environmental impacts are recommended. These recommendations are incorporated into a research and development plan. Approximate priority assignments derived from consideration of the timing of development and the importance and degree of definition of the identified environmental effects are given.

This report was submitted in fulfillment of Contract 68-01-0483 by Stanford Research Institute under sponsorship of the Environmental Protection Agency. Work was completed as of March 1974.

TITLE:

Studies of the Solid and Gaseous Products from Laser Pyrolysis of Coal

AUTHOR:

F.S. Karn, R.A. Friedel and A.G. Sharkey, Jr.

ADDRESS:

Pittsburgh Energy Research Center, Bureau of Mines, U.S. Department of the
Interior, Pittsburgh, PA

REFERENCE:

Fuel, Vol 51, No. 2, 119 (1972)

SUMMARY:

Laser pyrolysis of coal yields a variety of gaseous and solid products. Irradiation with high energy from a pulsed ruby laser produces (1) a gas having a high concentration of hydrogen and acetylene and (2) a solid having approximately the same elemental composition as the original coal. Low-energy irradiation with a continuous CO_2 laser produces (1) a complex mixture of hydrogen, carbon monoxide, and hydrocarbon gases and (2) a low-ash solid having a slightly lower C/H ratio than the parent coal. The solid has several interesting characteristics including a very low density and a high solubility in benzene. A high-resolution mass spectrum of this material revealed that it is a very complex mixture of organic molecules with many of the characteristics of coal. The solid has also been investigated by gel-permeation chromatography and catalytic dehydrogenation.

TITLE:

Laser Irradiation as a Rapid Screening Process for the Evaluation of Flame Inhibitors

AUTHOR:

Fred S. Karn, A.G. Sharkey, R.A. Friedel

ADDRESS:

Pittsburgh Energy Research Center, Bureau of Mines, U.S. Department of
the Interior, 4800 Forbes Avenue, Pittsubrgh, PA 15213

REFERENCE:

VSBM Contract Report USP/AD-M No. 71-306, January 3, 1973.

SUMMARY:

Inhibitors are used in coal mines as a precaution against accidental dust explosions. Although rock dust is the usual inhibitor many others have been tested. To facilitate testing a screening process using laser irradiation was proposed. The procedure includes irridation of a coal-dust mixture followed by mass-spectrometric analysis of the evolved gases and an evaluation of the flammability characteristics of the gases. Carbonate-type inhibitors decreased the percentage of combustibles in the gases generated and inhibitors like NcCl (thermally stable salts) decreased the total gas generated. A suitable test procedure did not result from the investigation, demonstrating the inadequacy of fast heating, non-combustive techniques in rating inhibitors of coal dust explosions.

TITLE:

Composition of Pyridine Extracts From Reduced and Untreated Coals as Determined by High Resolution Mass Spectrometry

AUTHOR:

T. Kessler, R. Raymond, and A.G. Sharkey, Jr.

ADDRESS:

Pittsburgh Coal Research Center, Pittsburgh, PA 15213

SUMMARY:

The purpose of this investigation at the Bureau of Mines was to determine the factors required for the solvation of coal. Because of the complexity of coal, in situ investigations of the chemical structure of coal often cannot be conducted. Coal extracts have been used by many investigators to study the constitution of coal. Chemical changes produced by the reduction of coal should be detected in pyridine extracts. For example a pyridine extract of a reduced vitrain should contain less sulfur than the corresponding untreated vitrain extract, as indicated by ultimate analyses of the coals.

High-resolution mass spectrometric analyses of pyridine extracts obtained from reduced and untreated vitrain showed 1. A greater concentration of oxygen - containing compounds in the reduced vitrain compared to the untreated vitrain. 2. A approximate 8-fold decrease in organic sulfur compounds in the vitrain following reduction, which is consistent with the decrease in S as shown by ultimate analyses. 3. A lower concentration of higher molecular weight hydrocarbons such as 3-ring aromatics in the reduced vitrain. 4. A significant increase in the amount of hydroaromatic compounds in the reduced vitrain.

TITLE:

Surface Mine Water Quality Control in the Eastern Kentucky Coal Fields. Water Quality Manual. Research and Demonstration of Improved Surface Mining Techniques for the Eastern Kentucky Coal Fields

AUTHOR:

Robert L. Kimball

ADDRES:

Kentucky Department for Natural Resources and Environmental Protection, Frankfort. Appalachian Regional Commission, Washington, D.C.

REFERENCE:

PB-262 578/8ST (NTIS)

SUMMARY:

This manual is intended to provide the reclamation inspector with indicators and procedures for identifying the acid pollution potential of an area in Eastern Kentucky proposed for surface mining. In addition, it provides the inspector with indicators for controlling acid pollution from permit application through bond release.

TITLE:

Surface Mine Water Quality Control in the Eastern Kentucky Coal Fields

AUTHOR:

Rober L. Kimball

ADDRESS:

Kentucky Department for Natural Resources and Environmental Protection,
Frankfort. Appalachian Regional Commission, Washington, D.C.

REFERENCE:

PB-262 579/6ST (NTIS)

SUMMARY:

This report and accompanying field manual offers the Commonwealth of Kentucky a means to aid in the control of chemical stream pollution resulting from surface mining. It attacks the source of the problem, chemical contaminants contained within the overlying strata associated with the coal seam. The study, designed and primarily aimed at the pre-mining identification of potential chemical pollution characteristics, will serve to strengthen state programs directed toward protecting Kentucky's teams and rivers.

TITLE:

Potential Radioactive Pollutants Resulting from Expanded Energy Programs

AUTHORS:

Hong Lee, Thomas O. Peyton, Robert V. Steele, Ronald K. White

ADDRESS:

Center for Resource and Environmental Systems Studies
Stamford Research Institute
Menlo Park, CA 94901

REFERENCE:

PB 272 519 (NTIS)
EPA-600/7-77-082
August 77

SUMMARY:

The radionuclide releases and the resulting population exposure doses from several energy systems for four projected energy utilization scenarios were calculated and compared. The energy system components examined were: coal mining, processing, combustion, and ash disposal; coal gasification and liquefaction; oil shale mining, processing, residue disposal and product utilization; geothermal development and operations; uranium mining, milling, conversion, enrichment and fabrication; nuclear reactor operations; and fuel reprocessing and waste disposal. The energy utilization scenarios included one that projected a high level of synthenic fuel production, one that projected high electrical power utilization--mostly derived from nuclear power developments beyond 1985, and one that assumes moderate developments in all energy systems along with energy conservation measures.

TITLE:

Pilot Plant Scrubbing of SO_2 with Fly Ash Alkalai from North Dakota Lignite

AUTHOR:

Harry M. Ness, Franklin I. Honea, Everett A. Sondreal and Phillip Richmond

REFERENCE:

Technology and Use of Lignite Symposium
Grand Forks, ND May 1977 (GFERC/IC-77/1) page 100

ABSTRACT:

A presentation of results on a pilot scrubber for scrubbing SO_2 from a slip stream of flue gas. Variables include CaO/SO_2 stoichiometric ratios; liquid-to-gas ratios; and suspended solids.

TITLE:

Identification of Components of Energy-Realted Wastes and Effluents

AUTHOR:

Dr. Edo Pellizzari

ADDRESS:

Research Triangle Institute

SUMMARY:

The long-term objective of the proposed research is to identify substances in wastes and effluents from energy-related processes. Information developed from this program will assist researchers who are concerned with control technology and monitoring techniques and the health and ecological effects of such energy-related pollution. The proposed work is divided into three phases. Phase A consists of a state-of-the-art summary and work planning which constitutes contacting EPA personnel to determine which energy-related solid waste and aqueous effluents have been analyzed for the purpose of identifying and measuring pollutants and which current contracts and projects will provide further identification. It will also consist of judging the reliability of existing information and the probability of accumulation of adequate data from current contracts and projects using pre-selected criteria. This information will be collated and summarized in a report for EPA. The report will identify gaps in existing and probable future data on chemical elements and volatile organic compounds in solid wastes and aqueous effluents from coal mines, oil refineries, oil-shale processors, coal-fired power plants, coal liquefication and coal gasification plants. Phase B consists of selecting sampling sites based on the recommendations from the report prepared in Phase A. The specific aims of Phase C consists of: (a) development and setup of analytical protocol, (b) qualitative and quantitative analyses for elements and organics in aqueous and solid wastes from the selected energy-related processes, and (c) the interpretation and collation of data obtained.

The proposed methods of analyses for the elements consists of flameless atomic absorption for mercury and spark source mass spectrometry for the qualitative and quantitative analysis for all elements through uranium in the periodic table of the elements expect oxygen, helium, hydrogen, neon, krypton, zeon, radon, nitrogen, carbon and mercury. Volatile and semi-volatile organic compounds in water and solid samples will be identified primarily by gas-liquid chromatography/mass spectrometry/computer analysis.

Potential Quality Control Standards

TITLE:

Trace Element Emissions: Aspects of Environmental Toxicology

AUTHOR:

Elliot Piperno

ADDRESS:

McNeil Laboratories, Inc., Fort Washington, PA 19034

REFERENCE:

Advances in Chemistry Series 141, 192, 1975

SUMMARY:

This general review of the toxicity of coal-based trace elements emphasizes those which are currently of environmental concern. Increased potential health risks are now associated with those elements which are highly volatilized (e.g., mercury, selenium, and arsenic) and discharged principally as submicron particulates (e.g., lead, cadmium, and nickel). Extensive references to general pharmacologic and toxicologic laboratory data provide a basis for predicting the biological consequences of excessive trace element exposure. Parameters and mechanisms of injury are known, in many instances, however, tolerable body burdens for each of the trace elements must be defined.

TITLE:

Spectral Studies of a Carbon Disulphide Extract of Bituminous Coal

AUTHOR:

H.L. Retcofsky and R.A. Friedel

ADDRESS:

U.D. Department of the Interior, Bureau of Mines, Pittsburgh Coal Research
Center, 4800 Forbes Avenue, Pittsburgh, PA 15213

REFERENCE:

Fuel, Vol. XLVII, 487 (1968)

SUMMARY:

The structure of the carbon disulphide extract of vitrain-rich Pittsburgh coal (hvab-82.6 percent C) was studied by various spectral techniques. The carbon disulphide-soluble material, which represented approximately four percent of the original coal, was obtained by extracting the coal with pyridine followed by extraction of the pyridine-soluble material with carbon disulphide. Both the pyridine and the carbon disulphide extracts were studied by ultra-violet-visible and infrared spectrophotometry and by electron and proton magnetic resonance. The carbon-13 magentic resonance spectrum of the carbon disulphide extract was also obtained. This represents the first application of this relatively new spectral technique to a coal extract and permitted a direct measure of the aromaticity. The mean structural unit in the carbon disulphide extract was found to consist of two to three polynuclear condensed aromatic rings with 0.4 of the available aromatic edge carbons bearing alkyl, phenolic, and/or naphthenic groups. The carbon disulphide extract was found to be less aromatic than the pyridine extract, and to contain a smaller condensed aromatic ring system while maintaining the same degree of aromatic ring substitution. The mass spectrum of the carbon disulphide extract indicated the presence of alkyl aromatic compounds having from one to more than ten alkyl carbons per molecule.

Infrared studies showed that complexation of pyridine with both extracts occurs. A new pyridine absorption band at 1000 cm^{-1} appears in spectra of the extracts moistened with small amounts of pyridine. Further evidence for the complexation of the carbon disulphide extract with pyridine was obtained by measuring its visible light absorption in carbon disulphide and in pyridine solutions.

TITLE:

Spectra of Coals and Coal Extracts: Proton Magnetic Resonance Spectra of Pyridine and Carbon Disulfide Extracts*

AUTHOR:

H.L. Retcofsky and R.A. Friedel

ADDRESS:

U.S. Department of the Interior, Bureau of Mines, Pittsubrgh Coal Research Center, Pittsburgh, PA

REFERENCE:

Spectrometry of Fuel, Chap. 6, 70 (1970)

SUMMARY:

High-resolution proton magnetic resonance (^{1}H NMR) spectrometry is a technique that can be used to study the hydrogen distribution in liquid products and soluble materials from coal. The relative amounts of aromatic hydrogen, benzylic hydrogen, and other nonaromatic hydrogen can be determined directly. Because all protons have essentially the same NMR sensitivity, no intensity calibration of the spectrometer is require; thus in this respect, ^{1}H NMR is far superior to may other techniques used in the investigation of coal structure. Unfortunately, high-resolution NMR is not applicable to whole coals, since the dipole-dipole interactions in solids generally prevent the observation of chemically shifted NMR absroption areas. Nevertheless coal extracts, which often represent a large amount of the whole coals, can be studied by the technique. The properties of extracts are thought to be similar to those of the whole coals from which they are derived.

In this paper, the hydrogen-atom distribution obtained by ^{1}H NMR and the carbon-atom distribution calculated by the method of Brown and Ladner are presented and discussed for pyridine and carbon disulfide extracts of six coals of United States origin.

TITLE:

Computerized System for Quantitative X-Ray Diffraction Analysis of Pyrite in Coal

AUTHOR:

R.R. Schehl and R.A. Friedel

ADDRESS:

Pittsburgh Energy Research Center, Pittsburgh, PA

REFERENCE:

Bureau of Mines Advancing Utilization Technology Program, Technical Progress Report 71, June 1973.

SUMMARY:

The Bureau of Mines has developed a quantitative analysis for pyrite in coal by X-ray diffraction that can be accomplished in little more than 1 hour. To minimize the sample analysis time, data processing has been completely computerized with pertinent output information displayed on a VR 12 cathode-ray tube display. Use of this computerized system is not only advantageous during the experimental stages of the pyrite analysis project but would also be essential if the X-ray diffraction procedure is accepted as a standard method of analysis.

TITLE:

An Evaluation of Methods for Detecting Mercury in some U.S. Coals

AUTHOR:

M.D. Schlesinger and Hyman Schultz

ADDRESS:

Pittsburgh Energy Research Center, Pittsburgh, PA

REFERENCE:

Bureau of Mines Report of Investigation 7609 (1972)

SUMMARY:

Mercury exists in coal in minute quantities, but the large tonnages of coal consumed could represent relatively large amounts of mercury entering the environment. Limits have not been placed on the emission of mercury, and it is important that reliable analytical methods be available to the chemist.

The Bureau of Mines has evaluated analytical techniques used by a number of laboratories; most used vapor phase atomic absorption as the final detection method. Neutron activation was used by some of the laboratories. All of the methods described could be applied, but they require careful manipulation to prevent loss or mercury contamination. In the samples analyzed the mercury content ranged between 0.04 ± 0.01 and 0.41 ± 0.06 part per million.

TITLE:

Analysis for Mercury in Coal

AUTHOR:

M.D. Schlesinger and Hyman Schultz

ADDRESS:

Pittsburgh Energy Research Center, Pittsburgh, PA

REFERENCE:

Bureau of Mines Managing Coal Wastes and Pollution Program Technical Progress Report - 43, Sept. 1971

SUMMARY:

Mercury exists in coal at very low levels; the structure of coal, the vapor pressure of mercury, and its almost universal occurrence introduce unusual problems into the analytical methods. Round-robin analyses by several laboratories, each using its own techniques, indicate that the average mercury content of coal is about 0.2 part per million. Some western coals are as low as 0.05 ppm.

TITLE:

High-Resolution Mass-Spectrometric Investigation of Coal Derivatives

AUTHOR:

A.G. Sharkey, Jr., J.S. Shultz, T. Kessler, and R.A. Friedel

ADDRESS:

U.S. Department of the Interior, Bureau of Mines, Pittsburgh Coal REsearch Center, Pittsburgh, PA

REFERENCE:

Spectrometry of Fuels, Chap. 1, 1 (1970)

SUMMARY:

High-resolution mass spectrometry has proven to be a useful analytical method not only for characterizing complex coal-carbonization products, but also for studying reaction of coal and coal derivatives.

The study of the coal-tar pitch resulted in the determination of precise masses corresponding to 128 chemical formulas composed of the elements C, H, O, N, and S. Of these, 49 formulas correspond to previously identified components of coal-tar products, 79 formulas indicate components with molecular weights not previously reported. A minimum of 47 structural types, compared to the 38 previously reported, are observed in these data.

The investigation of compositional changes occurring in road tars during weathering indicated that the rate of change with exposure time of oxygen-containing structures is greater than that of the polynuclear aromatics after 12 months and 24 months of exposure. Increases in both the average molecular weight and average number of rings per structural unit occur during weathering for all structural types observed.

High-resolution mass spectra of pyridine extracts of the original and reduce Pittsburgh vitrain supported theories proposed previously and gave further insight into coal solvation.

The feasibility of using high-resolution mass spectrometry to determine deuterated species in complex gaseous mixtures has been demonstrated.

This study shows that high-resolution mass spectrometry provides a means of detecting changes in either the concentration or compostion or organic compounds in coal derivatives following exposure to various atmospheres. While the identifiaction of particular structural isomers is not possible, the precise masses indicate the empirical formulas. Such information should lead to a better understanding of the properties of commercially important fractions of coal and its reaction products.

TITLE:

Nuclear Meter for Monitoring the Sulfur Content of Coal Streams

AUTHOR:

R.F. Stewart, A.W. Hall, J.W. Martin, W.L. Farrior, and A.M. Poston

ADDRESS:

Morgantown Energy Research Center, Morgantown, W. Va.

REFERENCE:

Bureau of Mines Advancing Energy Utilizing Program Technical Progress Report 74, January 1974.

SUMMARY:

A nuclear meter based on measurement of prompt capture gamma rays is being developed for monitoring the sulfur content of coal streams. Equipment has been built to measure sulfur rapidly, and methods have been devised to compensate for changes in moisture, ash, and bulk density of coal flowing through a bin. Pilot plant tests of the system with various additives to different coals show a precision and accuracy of 0.02 percent sulfur and 0.04 percent sulfur, respectively. Based on these results, a hardwired meter has been fabricated for testing in a commercial coal preparation plant.

TITLE:

Analysis of Trace Elements in Environmental Materials

AUTHOR:

H.E. Taylor & R. Brown

ADDRESS:

Accu-Laboratory Research, Inc.
Wheatridge, Colorado

REFERENCE:

Instrument Min. Metall, Ind., 2, 21, 1974

SUMMARY:

The use of spark-source mass spectroscopy to determine trace elements in coal, fly ash, soil, waste water, and air particulates is reviewed.

TITLE:

Effect of Strip Mining on Water Quality

AUTHOR:

J.P. Vinnerstedt, J.H. Finney, and P. Sutton

ADDRESS:

Ohio State University, Columbus, Ohio. Water Resources Center

REFERENCE:

PB-217 872/1 (NTIS)

SUMMARY:

The report deals with two separate topics, the effects of strip-mining on water quality of Little Mill Creek, Ohio, and infiltration of water on strip-mine spoil banks. Chemical water quality in Little Mill Creek was measured for 236 weeks. Two of four sampling points received effluent from a coal strip-mine. Sulfate, manganese, calcium, magnesium, iron, aluminum, and hydrogen ion concentrations were determined. Rainfall infiltration on graded spoil banks, measured with a sprinkling infiltrometer, averaged about 1.5 cm per hour. Differences in moisture content, slope, bulk density, and texture of the spoil did not explain most of the difference in infiltration between spoils.

TITLE:

Hydrogenolysis of Urethanes: Deoxygenation of Phenols

AUTHOR:

J.D. Weaver, E.J. Eisenbraun and L.E. Harris

ADDRESS:

Oklahoma State University
Stillwater, OK 74074

REFERENCE:

Chemistry and Industry, 197 (1973)

SUMMARY:

Our synthesis of 1,4-dimethylindan via the Pd/C catalysed hydrogenolysis of 2-(1,4-dimeth -7-indanyloxy) benzoxazole in ethyl acetate led to the discovery of urethanes as new derivatives useful in deoxygenating phenols. We found that Pd/C catalysed hydrogenolysis of urethanes in acetic acid gives the corresponding arene in good yield. This paper details these developments and gives many representative examples performed by us.

TITLE:

Low-Temperature Fourier Transform Infrared Spectroscopy of Polynuclear Aromatic Hydrocarbons

AUTHOR:

E.L. Wehry, G. Mamantov, R.R. Kemmerer, H.O. Brotherton, and R.C. Stroupe

ADDRESS:

Department of Chemistry, University of Tennessee
Knoxville, TN 37916

REFERENCE:

"Carcinogenesis", Vol 1, Polynuclear Aromatic Hydrocarbons: Chemistry, Metabolism, and Carcinogensis, edited by R.I. Freudenthol and P.W. Jones. Raven Press, NY (1976)

SUMMARY:

The scope of the applicability of Fourier Transform Infrared Spectroscopy to the quantitative and qualitative analysis of polynuclear aromatic hydrocarbons, particularly in submicro amounts, is discussed. A short review of the construction and capabilities of the Fourier Transform Infrared Spectrophotometer is given. Sampling techniques appropriate to this method of analysis are compared with particular emphasis on the Matrix Isolation method, of which there is an extensive discussion. Several examples of spectra are given, along with a modest bibliography.

TITLE:

Comments on the Collection and Storage of Mine Effluent Waters

AUTHOR:

Thomas R. Wildeman and Armando J. Ramirez R.

ADDRESS:

Department of Chem. and Geochemistry, Colorado School of Mines, Golden,
CO 80401

REFERENCE:

April 26, 1976

SUMMARY:

Two of the questions which must be considered when developing analytical methods on a specific material are how does sample preparation bias the analytical results and does the material change upon storage. This note describes various tests which have been made to try to pin down some of the aspects of these two questions which affect mine effluents.

TITLE:

Inorganic Chemical Analysis of Mine Drainage Waters

AUTHOR:

Thomas R. Wildeman and Armando J. Ramirez R.

ADDRESS:

Department of Chemistry and Geochemistry, Colorado School of Mines, Golden,
Colorado 80401

SUMMARY:

A scheme is described for the analysis of inorganic constituents in mine drainage waters with particular attention being paid to the problems that the high iron and sulfate concentrations might cause in standard analytical methods. It is found that Fe, Mn, Zn, Cu, Na, K, Mg, Cd, and Pb can be accurately analyzed in mine drainages using direct analysis by atomic absorption spectrometry. However, the matrix can interfere in the analysis of Ca and methods for eliminating the interference are given. Also, interferences have been encountered in the determination of As by the arsine generating method and the analysis of SO_4 by the indirect barium precipitation method. The determination of low concentrations of base metals by the solvent extraction methods used in atomic absorption is also hampered by the high Fe concentrations in mine drainage waters. Methods for eliminating the interference using different chelating agents met with only limited success. The analysis of trace amounts of Cu, Pb, and Cd in mine drainage by anodic stripping voltametry appears to be a promising alternate method when solvent extraction cannot be used.

During the course of this investigation, standard mine drainage (SMD) were made to check matrix interferences and maintain quality control. The SMDs were made such that the concentrations approximinated the highest to be found and then this was diluted to required levels. The dilutant is always 0.05% HNO_3 so that the matrix of samples and standards is the same. Recently, the first standard prepared in February, 1974, and dilutions of this standard made at the same time were tested for deterioration of the elemental abundances. No changes to within ± 5% were found in any of the elements tested in the original standards or its dilutions. All these tests were performed by atomic absorption using direct aspiration.

TITLE:

Syncrudes Characterized by Compound Types Using Gel Permeation Chromatography-Mass Spectral Correlations

AUTHOR:

P.W. Woodard, G.P. Sterm, Jr., J.E. Dooley

ADDRESS:

Bartlesville Energy Research Center
P. O. Box 1938
Bartlesville, OK 74003

SUMMARY:

The types of compounds in aromatic concentrates derived from synthetic crude oil distillates can be estimated from a gel-permeation chromatographic (GPC) analysis by the use of tables developed from extensive GPC and mass spectral analyses on fractions from four crude oils and numerous pure compounds. For a given fraction from the GPC analyses; the retention volume and the molecular weights (from mass spectrometer) suffice to indicate the predominant types of compounds. The correlations and tables were developed for petroleum derived samples, but they have proven to be applicable to synthetic crude oils as well.

Potential Quality Control Standards

TITLE:

Comparison Studies of the Organic Constituents in Different Solvent Refined Coals as a Function of the Feed Coal

AUTHOR:

D.L. Wooton

ADDRESS:

Department of Chemistry
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

SUMMARY:

The solvent refined coal (SRC) process is one of several processes currently under consideration for converting coal to a relatively ash free, low sulfur fuel. Chemical characterization of the heterogeneous semisolid SRC product obtained from this process should provide a better understanding of the SRC process and perhaps new insight regarding coal processing in general.

Potential Quality Control Standards

TITLE:

Water Infiltration Control to Achieve Mine Water Pollution Control - A Feasibility Study.

AUTHOR:

Frank J. Zaval and John D. Robins

ADDRESS:

West Virginia Department of Natural Resource, Charleston, WV

REFERENCE:

PB-217 886/1 (NTIS)

SUMMARY:

The study determined the feasibility of conducting a full-scale demonstration to document the effectiveness of land reclamation at mined-out areas in establishing surface water infiltration control to prevent acid mine water pollution. The study site was the Dents Run Watershed, Monogalia County, West Virginia. Investigative measures included: investigation of each mine area and opening; a detailed description of each site; sampling and analysis of all receiving streams and discharges points to determine the severity of acid mine water pollution; and evaluation and selection of weir structures, monitor enclosures and instruments to be placed in unattended areas to provide a continuous record of stream conditions. Recommendations and cost estimates are presented for reclamation at each site and for the installation of monitoring facilities.